THE

ELECTRICAL REVIEW.

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THE ELECTROPATHIC BELT LIBEL SUITS.

IT was naturally expected that at the conclusion of the recent belt cases we should have reviewed, at considerable length, the subject of the electropathic belts, and have given our final opinion on the matter. There were many points upon which we were desirous of commenting and offering some explanation. But we were prevented from doing this by an action taken against us by the Medical Battery Company being still *sub judice*, or rather we considered that it would be injudicious to speak of matters which had not been before the Court. Probably we might have discussed the subject with safety, for it was extremely unlikely, after the decisions, that another action would be fought out; but we were dealing with people who would not be slow to avail themselves of any error of judgment on our part, if it were likely to lead to any disadvantage to us. The action brought by the Medical Battery Company against us has only been disposed of during the last few days, when, upon the application of our solicitors, the action was struck out of the list. Now we are at liberty to discuss the subject, and though the matter cannot at the moment be considered of paramount importance, there are some facts which the late trials brought forth which are worthy of being placed upon record.

It is scarcely necessary to say that the results of these actions were most gratifying to us, not only because the legal decisions had more than justified the uncompromising and rigorous attitude we had taken up with regard to Harness and his quackery, but because these actions clearly showed how many scientific men were willing to help us. It was the most gratifying feature in the whole of the affair to find we had so many good friends who were willing to sacrifice valuable time, and come without the least hesitation into the law courts to help us to make good our cause. We had an array of scientific men of the highest eminence which, we venture to think, has never been seen on one side of any legal suit. Lord Kelvin, P.R.S., and Dr. Bottomley, F.R.S., with great kindness, gave much consideration to the matter before the trial of the action, and Lord Kelvin came, at much trouble to himself, notwithstanding a somewhat serious illness, to give evidence for us. His evidence was of the greatest weight, and must have had great effect on both judge and jury. Mr. Swinburne, Prof. Silvanus Thompson, F.R.S., Mr. Crawley, Mr. Crompton, Mr. Latimer Clark, F.R.S., Mr. Spagnoletti, Mr. Desmond Fitz-Gerald, Mr. Rollo Appleyard, Mr. Ed. C. de Segundo, and Mr. John Gray, were present at most of our conferences, and assisted at and made many experiments. Mr. J. E. H. Gordon was with us the evening before his untimely death, and aided us a great deal with his valuable advice. Besides these, we had the greatest service rendered to us by the medical gentlemen, Dr. Lewis Jones, Dr. de Watteville, and Dr. Inglis Parsons, who were most active in the conduct of the case. Dr. Lewis

Jones, with his special electrical knowledge and medical skill, enabled us to carry out experiments which we could not otherwise have performed. Mr. Alexander Siemens, Mr. Wm. Mordey, Mr. Kent, Prof. Jamieson, Mr. Sidney Wallis, of Guy's Hospital, Mr. Charles Gatehouse, Dr. Victor Horsley, Dr. Sansom, Mr. W. T. A. Beare, Mr. Newman Lawrence, Mr. de Tunzelmann, Prof. Hughes, and Mr. Thistleton, were ready to give evidence, while we had many expressions of sympathy from gentlemen who, for official and private reasons, were unable to appear in the witness box. We owe these gentlemen a debt of gratitude, and we take this opportunity of publicly thanking them for their great services. At the same time, we wish to place on record our indebtedness to our electrical and medical contemporaries, who gave us much support and sympathy during the progress of the actions.

It will be interesting to show the course of events which led up to these actions, for they are somewhat remarkable. For the past five or six years we have on many occasions published articles calling attention to the worthless nature of the so-called electropathic belts. In consequence of these articles there have been indistinct threats of actions for libel, but proceedings were never commenced. Our position in the matter had been well considered; no one knew better than we that we ran the risk of making infractions on obscure clauses of the libel Act, but the nature of the belt business was so obviously bad, so glaringly reprehensible, that we were quite prepared at any time to go into Court and show that our contentions were based on indisputable facts. It has been said over and over again that our attacks were not likely to serve any useful purpose, because the general public, who were the supporters of this charlatanry, were out of the reach of our arguments. The sequel has shown otherwise, and that our continual attacks have cleared away a good deal of the web of hypocrisy which has surrounded this great electrical imposture. Besides, was it to be expected that a man who traded upon the gullibility of the public solely on account of his supposed electrical qualifications was to go unchallenged? We say here, in the most emphatic manner, that it was our duty to show that the means adopted for the curing of many forms of disease were of the most unscientific character. The whole business was a hideous mockery, and we should not have had clear consciences if we had not pointed out the sham nature of the treatment. It was to us an appalling thing that a man could be found so utterly wanting in sympathy as to pretend to cure the most pitiful disease. It was but gibing and mocking at suffering; with this knowledge could we do otherwise than attack with the strongest force at our command this bogus institution? This attitude we shall always maintain, and strengthened by these decisions we shall not relax our efforts in pointing out what we consider to be unsound.

In spite, however, of the severity of our attacks, it is curious that no action was voluntarily commenced against us, but on September 16th, 1892, the following letter was sent round indiscriminately to newsagents in London:

> Having been consulted by my clients, the Medical Battery Company, Limited, the proprietors of Harness's Electropathic and Zander Institute, of 52, Oxford Street, W., with reference to some malicious libels published in the ELECTRICAL REVIEW and a paper called *Science Siftings*, I beg to give you notice that if these or any future publications containing defamatory articles or paragraphs are sold by your firm, my clients will hold you responsible. In the same way you will be held responsible for the exhibition of any libellous bills or placards.
>
> AUG. FLEET.

This document sent broadcast among newsagents was calculated to have a most serious effect on our relations with the agents, and when we had received some dozen enquiries or so from newsagents, we decided upon prompt action. Messrs. Lewis and Lewis advised that an action could be maintained, and proceedings were at once commenced against the Medical Battery Company. It was necessary to give letters of indemnity to the newsagents before they would continue the sale of the ELECTRICAL REVIEW, in fact, it was fully established at the trial that one or two had absolutely stopped selling in consequence of receiving the letter from the solicitors of the Medical Battery Company. Our arrangements were very much strained with Messrs. Smith and Sons, who are among our largest customers, in fact much larger than was inadvertently stated by their clerk in the witness box. They held that a letter of indemnity was insufficient to warrant them continuing the sale of the paper. It was necessary to assure them that no libels on the Medical Battery Company would be published. The best that we could do was to assure Messrs. Smith that no libels would be published; but then our view of what was libellous in an article might not coincide with that of a court of law. We mention these facts to show how serious a matter the issuing of the letter was to us. The writs in the action were taken out on September 22nd, and on the following day the Medical Battery Company served writs upon us for the publication of various libellous articles. It is fair to assume that these writs would not have been served upon us had we not commenced the action on the previous day. Some weeks later, in consequence of a critical review of a Medical Battery pamphlet, written by Dr. Tibbits, an action was commenced against us in the name of Tibbits. We had now three actions to fight, and with the knowledge that they would be of the utmost importance both to us and the public, we set to work to arrange our evidence, and obtain new testimony as to the worthless nature of the cures. There was no lack of witnesses who were quite prepared to go into the box and declare the nature of the treatment they had undergone at the hands of the Medical Battery Company. We had numerous belts purchased for us at different times, and experimented on all of them. As we have already mentioned, our scientific friends had promised their evidence, and we arranged meetings, at which were devised some simple experiments which would be of use in convincing a judge and jury of the nature of an electric current. It was, perhaps, doing too much honour to the belt; but it was very necessary that the judge and jury should be possessed of some knowledge of electricity before we could point out the uselessness of the belt as an electrical appliance.

The action of Dr. Tibbits against us was, for reasons well known to the Medical Battery Company, pushed on as rapidly as possible. Although we were perfectly satisfied that the strictures we had passed on the pamphlet written by Dr. Tibbits were thoroughly justified, and that we should have no difficulty in establishing our contentions, yet we were in certain respects fighting the case at a disadvantage. We were, as a matter of fact, fighting a man behind a hedge. It would not be assuming too much to say that Dr. Tibbits was pushed forward by Mr. Harness solely in the hope that we might at the outset be crippled with a decision against us. The money to fight the action, according to Dr. Tibbits

himself, was being provided by Mr. Harness; no doubt a verdict against us would have been held as a triumphant vindication of the virtues of the electropathic belt, while a verdict for us would only have affected Dr. Tibbits.

What might have been an unfortunate incident for us happened while waiting in the Law Courts for our case to come on. Mr. Finlay, Q.C., had been retained for us, and had had our brief in his hands for some days. Two days had been wasted in the Courts, when late in the afternoon of the day preceding the taking of our action, Mr. Finlay, on account of an important case in the House of Lords, was compelled to return the brief. Our case was the first in the next morning's list, and in the few hours left we had to find and instruct fresh counsel. It was not until an hour before the case came on for hearing that we were certain that a leader would appear for us. However, Mr. Lawson Walton arrived in time to conduct the case, but there was little more than half-an-hour in which to instruct him. It must be remembered that this was a case where a good grasp of electrical laws was of the utmost importance; there were matters which required the most delicate handling in order to bring conviction to the mind of a jury. The whole of our defence was based solely on scientific grounds, and in the hands of less able counsel than Mr. Walton it would not have been surprising if our points had been obscured. Of course we depended a great deal on the unquestionable authority and unimpeachable character of our witnesses. Besides, we had in Mr. Bankes, our junior counsel, a man who could fight well in any emergency, and who had complete mastery of the technical points in our case.

What we considered to be the real issue of the case was not shared by Mr. Justice Mathew. We thought the matter would mainly turn upon the manner in which the Medical Battery Company conducted their business, but on the ruling of the Judge, we were compelled to confine our attention to the pamphlet written by Dr. Tibbits. This precluded us from bringing into the case the evidence of those who had suffered at the hands of the Medical Battery Company. The evidence of Lord Kelvin, Professor Silvanus Thompson and Mr. Swinburne, clearly showed that the pamphlet written by Dr. Tibbits was wrong in fact, and no amount of finessing from the opposing counsel was able to spoil the effect of these statements. Mr. Lawson Walton in his most able and powerful address to the jury, struck the right note, and Mr. Justice Mathew placed the whole matter at issue in a clear light, and as is well known, the jury gave a verdict in favour of the ELECTRICAL REVIEW. It was next our turn to act as plaintiffs, and our action against the Medical Battery Company for the circulation of the letter came on. We went into this action confident that the whole matter would be brought before the Court; but we reckoned too soon, for Sir Edward Clarke, for the plaintiff, admitted that the letter was a libel. Again the evidence which we had obtained at the cost of a good deal of time and trouble was stifled. Mr. Finlay said, rightly enough, that the defendants would never be prepared to meet the real issue of the case; they preferred to pay damages, and £1,000 was awarded to us in this respect. It was pretended that the belts formed the subject of another action; but as the Lord Chief Justice remarked, it was extremely unlikely that this action would ever be brought. This observation was perfectly true, for it is this action which has just been struck off the list.

We most heartily commend the manner in which these actions were fought for us by Mr. Finlay, Q.C., Mr. Walton, Q.C., and Mr. Bankes. It was gratifying to find counsel so ready to appreciate the strong points of our case. We could not conclude this article without referring to the able way in which Mr. Lickfold, of Messrs. Lewis and Lewis, prepared the case. From the peculiar nature of the actions, they must have given considerable trouble to him; how well they were prepared is best shown by the results. Personally we thank him for the great interest he took in the actions, apart from the purely professional aspect.

Our special thanks are due to Mr. Preece, who placed at our disposal the instruments and the testing room of the Post Office.

We understand that a Defence Fund was liberally subscribed to, and although the circumstances were such that we did not need help of the kind, yet we appreciate the kindness of the members of the committee who initiated the fund, and express our obligations to them, as well as to those who subscribed to it. It is quite possible that in the hurry of preparing this article we may have inadvertently omitted the names of gentlemen who promised us their support; if this is the case, we would be glad to be reminded of it.

E.M.F. Standards.

IN these days of exact electrical measurements the question of a good standard of E.M.F. is very important. The standard generally in use is Latimer Clark's cell, but it labours under the disadvantage of having a considerable temperature correction. Mr. Weston, whose work on resistance alloys and standard instruments is so well known, thought of substituting the metal cadmium for zinc in this cell, as the solubility of cadmium salts is nearly independent of the temperature, and it is a member of the same family as zinc. He has thus been enabled to get a cell which has a temperature coefficient of not more than ·01 per cent. per degree, and its absolute value is nearly exactly 1·019 volt. The salts employed are the same as those used in the Clark cell, substituting cadmium for zinc.

Magnetisation Measurements.

THE well known researches of Ewing are being followed up by H. Lehmann, who has recently been investigating the magnetisation of iron rings slit in their radial direction. He first determined the normal curve for the ring before it was slit, using Ewing's method with ballistic measurement. Then, the ring being slit radially and the dimensions of the slit adjusted by means of an arrangement of plane, parallel brass discs introduced between the surface with a brass collar for tightening purposes, he proceeded to determine the flow of induction across the space, fine copper wire being wound round the disc. A large number of measurements were taken, from which it was found that the ratio of the mean induction to that of the slit, or, in other words, the coefficient of dispersion increased according to the dimensions of the space, and decreased when the intensity of the magnetic field, which was varied from 1 to about 300, was increased. It was observed that the coefficient of demagnetisation was constant up to about the half-saturation point. The paper in which this research is described may be consulted in *Wiedemann's Annalen der Physik und Chemie*, 1893, pages 406—445. The bulk of it consists in a description of the experiments, with diagrams, a tabulation of the results, and the mathematical analysis of these results. Several new formulæ are given.

ARC LIGHTING.

By E. TREMLETT CARTER.

(*Continued from page* 710).

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IV.

IRON pipes for cable conduits are composed of cast or wrought-iron, the former material being employed for large diameters capable of taking both cables, and the latter for small conduits designed to carry only one small cable. Wrought-iron is less durable, but much tougher and lighter to handle than cast-iron, and for the smaller sizes of conduit is the cheaper of the two. It is usually from 1½ to 2½ inches in diameter for series cables for arc lighting, and is made in lengths of from 12 to 15 feet, though it may be obtained up to 20 feet in length. The shorter lengths are easier to handle, but involve more conduit joints. The joint is sometimes made by means of a muff or sleeve connecting tube, which screws on to the two ends to be jointed. The two ends are cut on the outside with a right and left gas thread respectively, and the inside of the sleeve has a similar thread cut on it. By this means a smooth bore butt-joint is produced, which does not injure the cable when it is drawn through, and one which is sufficiently watertight and elastic for the work. If a perfectly watertight joint is required, the ends of the pipes should be luted with red lead cement over the threads. The length of the sleeve should be not less than from twice to two-and-a-half times the diameter of the pipe, and the thickness of both pipe and sleeve, for a 2½-inch conduit, may be about No. 8 B.W.G., or 0·166 inch. This will be the thickness where the pipes are well bedded in concrete, so that strains are not likely to arise from subsidence of soil; but in loose soils, which are not well rammed and firmly bedded, the thickness must be greater. Fig. 3 gives

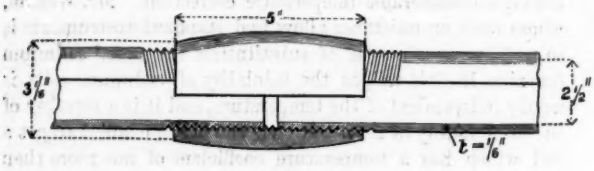

FIG. 3.

a drawing of a wrought-iron conduit joint. Very frequently the sleeve is made in one piece with the pipe, forming a socket into which the end of the other pipe is screwed. Cast-iron pipes require to be very much thicker than wrought-iron pipes, on account of the brittleness of the material and owing to the liability to the development of flaws in casting. They should be cast vertically, socket downwards, in order to equalise the thickness, and in no case should the thickness of a 4-inch conduit be less than ⅓ inch, or of a 6-inch conduit less than ½ inch. Small 4-inch conduits will usually be used for series arc lighting, and it is advisable to have a thickness of at least ½ inch of metal. Grey, or a mixture of grey and white re-melted cast-iron, having a tensile strength of about seven to eight tons, and a crushing strength of at least 35 tons per square inch, before fracture, should be specified. A test piece of the metal should show an uniform greyish fracture, and there should not be more than 2·75 per cent. nor less than 1·75 per cent. of graphite residue when the metal is slowly dissolved in dilute sulphuric acid. Cast-iron withstands the action of chemicals in the soil and of various gases better than wrought-iron, and is on this account more durable when used for conduits. It may be further protected from corrosion by being painted on the outer surface with a coating of bituminous material; and wrought-iron may be similarly protected by being galvanised or by a serving of bituminised jute. All metal conduits should have their inner surfaces well scoured to remove the roughness of the surface and the burr on the edges, otherwise the cable is injured in drawing through.

Various kinds of cast-iron pipe joints have been tried for conduits, but the most successful appear to be the leaded socket joint. The long experience of the Post Office in this matter has proved that this form of joint is preferable to the stronger but less flexible and more expensive flanged joint. Fig. 4 shows a leaded socket joint, as commonly used. One end of each pipe is bulged or expanded to a larger diameter, so that the unexpanded end of the adjoining pipe will fit into it with an easy fit. The mode of making the joint is as follows:—The two pipes, A and B, are fitted together, preferably on the bed of the conduit, so as not to strain the joint by moving it. If the joint cannot be made

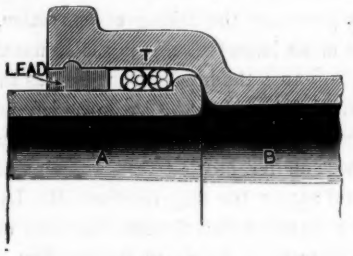

FIG. 4.

in situ, there must be provision made for carefully lowering the pipes into place; but this is always bad, as it strains the joints and makes them leaky. When the pipes are socketed into one another a few turns of tarred hemp should be wound round the inner pipe, and stemmed into the inner end of the joint, as shown at T. Clay is now luted over the end of the socket, a hole being left at the top for pouring melted lead into the space between the tarred yarn and the clay. After the lead has been poured in and has cooled, the clay is broken away and the lead is tightly stemmed into the socket. A few turns of red lead cement and yarn may be wound over the outside of the lead, to prevent corrosion by local action between the iron and the lead; but this is not always done. Instead of a lead joint a rust joint is sometimes used, the only difference being that the socket is stemmed with iron cement with a cold chisel instead of being filled with cast lead. Fig. 5 gives the usual proportions of the spigot and

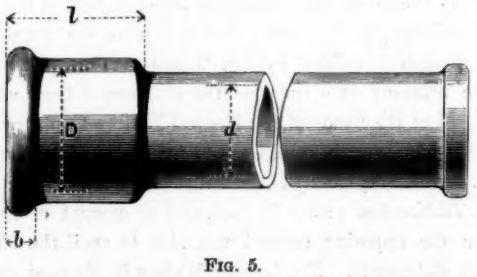

FIG. 5.

socket ends of a cast-iron pipe, the equations for which are as follows: Let d be the diameter of the pipe, and D the diameter of the inside of the socket, and let t, t_1, and t_2, be the thicknesses of the pipe, the socket, and the flange respectively, and l and b the lengths of the socket and flange respectively; then,

$$t_1 = (0{\cdot}025\text{d.} + \tfrac{1}{4}) \text{ to } (0{\cdot}025\text{d.} + 0{\cdot}6)$$
$$t_2 = 0{\cdot}045\text{d.} + 0{\cdot}8$$
$$\text{D} = 1{\cdot}02\text{d.} + \tfrac{1}{2}$$
$$l = (0{\cdot}09\text{d.} + 2\tfrac{3}{4}) \text{ to } (0{\cdot}1\text{d.} + 3)$$
$$b = 0{\cdot}03\text{d.} + 1.$$

For temporary conduits, such as may require to be laid for exhibitions, &c., spigot and socket pipes may be jointed by ramming a rubber ring into the space between the spigot and the socket, after the two have been telescoped in the usual way. This is cheaper and more easily removed than lead jointing. Conduits that may be subjected to any considerable longitudinal stress, must not be jointed in any of the above-named ways, but should be securely bolted at the joints by means of flanges, as shown in fig. 6. Such conduits will

occur on steep declivities, where the pipes are laid on the ground, or where cables have to pass vertically from one level to another through pipes. Such flange joints are not so flexible as sockets, and on this account they should be protected from cross strains by securely anchoring the lines of pipes. The dimensions in fig. 6 are for a 4-inch pipe, suitable for carrying a couple of cables, each one inch in diameter or under.

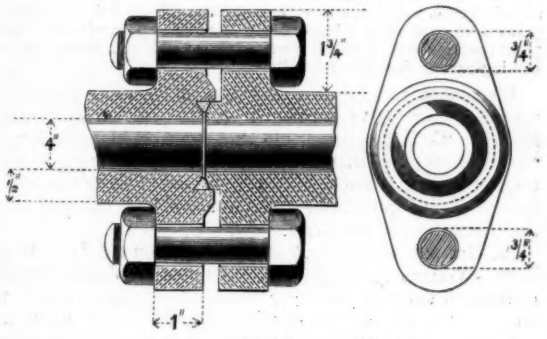

FIG. 6.

Conduits for vulcanised rubber cables need not be very carefully made watertight, if provision for drainage is made. Under level ground the lines of pipes should be set with a slight declivity towards the draw boxes, in order to allow any water which leaks in to drain away. Where a conduit runs down to a valley and up the other side, ample provision for drainage must be made at a draw box at the bottom. Drainage is best carried out at the draw boxes, and may very simply and efficiently be arranged by bedding the frame of the box in porous soil, there being several perforations in the bottom of the box. If the soil is so dense that drainage cannot be effected in this way, the draw boxes must be trapped

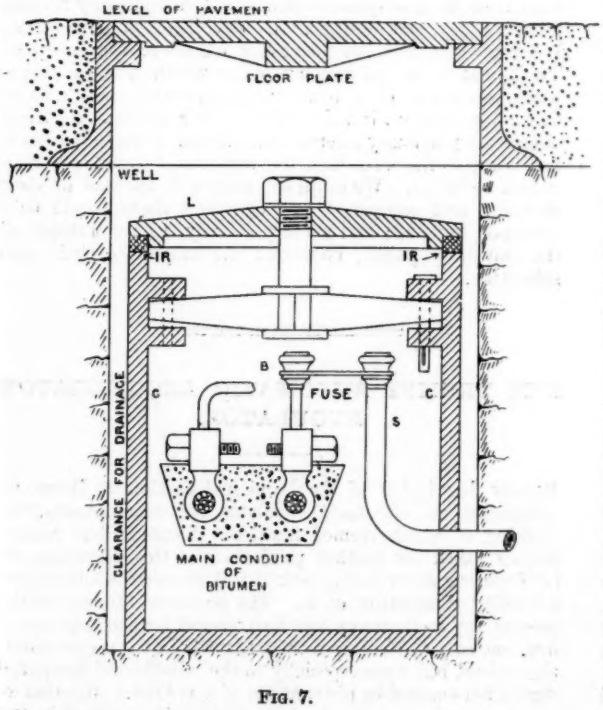

FIG. 7.

into some system of drains; but this is rarely necessary on a light line, such as would be used for series arc lamps, and its costliness would lead one to adopt the simpler method wherever possible.

Draw boxes, or drawing-in boxes as they are sometimes called, should be placed near enough together to enable the cable to be properly drawn through without injury, so that their distance apart will depend on the straightness of the route and the weight of the cable. For straight runs and moderately light cables, they may be placed about 100 yards apart, and one should be placed at every sharp bend in the conduit. Bare copper cables require double boxes, consisting of a well with an ordinary floor plate or cover, and an inner box of cast-iron, with a watertight cover. Such a box is shown in fig. 7, which illustrates a junction in a parallel system, with bare copper mains laid in bitumen. The inner cover, L, is made watertight by means of an India-rubber ring, I, R, and there is a clearance between the inner box, C, and the sides of the well for drainage. Where covered cables are used a very much simpler and cheaper draw box will generally suffice, and a good form for this purpose is shown in fig. 8. This consists of a cast-iron box with a single

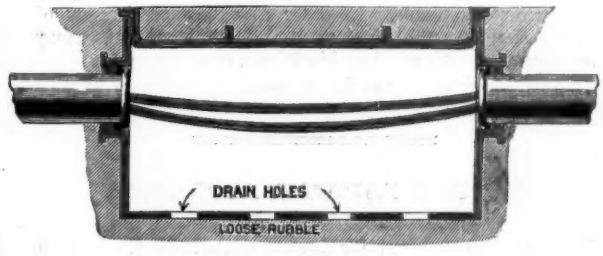

FIG. 8.

cover and perforated bottom. The cover is made of a cast-iron frame, filled in with concrete to match the pavement and prevent it becoming slippery. The ends of the iron pipes are socketed into the sides of the box, by means of packing boxes cast into the sides. The spigot ends are passed into the packing box, and the space between filled up with cast lead. The cover is usually luted down with red lead cement to make it fairly watertight.

The cost of a cast-iron conduit for series lighting, to carry about 10 ampères, will be approximately as follows:—The vestry charges for making good the pavement will vary from 3s. 6d. to 20s. per yard, according to the nature of the paving, and, perhaps, according to the vestry. Macadamised road is the cheapest, and asphalte seems to be the most expensive pavement to disturb. Foot paving will cost about 3s. 6d. per yard, if made of ordinary flag stones; and, as the insulation under these is always better than under the roadway, the conduit will be placed under the footpath wherever possible. The cost of pipes and material for pipe joints, delivered on the ground, may be taken as from 15d. to 18d. per yard run per 2-inch way. The inclusive cost of laying this conduit, with the necessary draw boxes, will therefore be about 11s. or 12s. per yard, including only a single yard of the high-pressure cable. Where both return and forward cables are carried in the same conduit, the cost of the conduit will be about 12s. or 14s. per yard, assuming the cable to have an insulation resistance of at least 2,000 megohms per mile.

In order to facilitate the drawing-in operation, and to obviate the use of rods, which are inconvenient, or of sagacious "cable-laying" dogs, which are a rare breed, it is customary to place a thin galvanised iron wire in the conduit as it is laid. When the cable is to be drawn into the conduit a stout rope is secured to the iron wire at one of the draw boxes, and is drawn into a section of the conduit by drawing out the iron wire at the next box. To the end of this rope the beginning of the cable is securely and smoothly fastened, and then the rope is drawn out in the same manner as the iron wire, the end of the cable following it into the conduit. While the cable is being drawn into the first draw box it is carefully wound off the drum on which it is stored; and, if there are two cables to be drawn in at the same time, these are bound together at intervals as they pass into the draw-box. As soon as the end of the cable appears at the box where the men are drawing at the rope, it is seized, and a quantity of cable is drawn out and flaked on the ground. When as much as can be conveniently drawn through at one time has thus been treated—on short lengths, this will be the whole length that is to be passed on; on long lengths it may be only a part of this—the rope is drawn into the conduit again, but is passed this time into the next section; and in

the same manner a length of cable is drawn through and flaked on the ground at the third draw-box. The operation is repeated as many times as may be necessary to get the cable properly into the entire length of the conduit for which it is made; care being taken, where there are two cables bound together, to sever the bindings as they pass into the last section, namely, the section in which they are to remain. It is also the custom to draw a thin rope into the conduit with the cable, to facilitate the drawing-in of a new cable when necessary; but this may be dispensed with when there is no likelihood of having to increase the number of cables, as on a series arc lighting circuit. When, on account of a fault and the necessity for repair, a length of cable is drawn out of the conduit, a thin rope should be made fast to it in such a manner that it will be drawn into the conduit. This rope will be used to draw in the thicker rope for hauling the new or repaired cable. In order to reduce the friction of the cable against the pipes as it is drawn in, the cable may be lubricated with whiting, black lead, or soft soap.

(*To be continued.*)

RECENT RAILWAY ACCIDENTS.

FROM the report of Major Marindin, R.E., on the collision which occurred at New Mills Junction, on the Sheffield and Midland Joint Railway, on March 3rd last, we gather that although there is some confliction in the evidence, it would appear that the collision was due mainly to a mistake on the part of the signalman, who "unfortunately forgot before accepting this train to alter the position of the junction facing points, so that the Midland train, instead of being turned off the main line on to the Hagfield branch, was pushed back along the up main line across the junction," &c., &c. The quotation is from the report; and, based upon it, although we do not observe any such recommendation on the part of Major Marindin, we cannot but think that had the signals—electric and mechanical—been interlocked, the accident would have been avoided.

The same inspecting officer, in dealing with the collision which occurred at Baker Street, on the St. John's Wood branch of the Metropolitan Railway, on January 20th, after commenting upon the circumstances of the collision, observes:—

> Under the mode of working on the Metropolitan Railway, and with the instruments in use, a signalman cannot, until a train has passed over a treadle fixed in advance of his home-signal, either give permission on his block instrument for a second train to leave the cabin in rear, or release his electric lock on the starting-signal at this cabin, which signal is therefore kept at danger.
>
> This union of "lock-and-block" is a most valuable safeguard, but it ought to be carried out thoroughly, which is not quite the case at Baker Street, for, although at this station and throughout the system of the Metropolitan Railway Company the collision of a train with a preceding running train is guarded against, it is apparent from the evidence that after a running train has passed forward and released the block instrument by means of the treadle, another train can be allowed to approach when the line has been fouled by an engine or train being let out of a siding, which is quite as dangerous as if a running train were stopped in the same position.

It would appear, from a letter received from Mr. J. Bell, the general manager of the Metropolitan, that the practice of allowing the treadle to be operated by a light engine after a train has passed into the section, has been unauthorised and has been strictly forbidden. This is, so far, satisfactory, but we hope Mr. Bell will go further than this, and make it impossible for the points or signals connected with the section to be operated in such a manner as may lead to disaster. Positive instructions are exceedingly good things in their way, but they are not so good as that which renders it physically impossible to disregard them.

In reference to a collision which occurred at the Richmond station of the London and South-Western Railway on January 31st, we cannot do better than quote Major Marindin's remarks. The collision was the result of a train having been turned into a siding, which was at the time occupied by another train. With the object of reminding the signalman when a siding is occupied, he is required to place a metal tablet, provided for the purpose, over the handle of the lever commanding the siding. This he omitted to do, and the presence of the train was thus forgotten.

> The signalman considers that the tablets referred to above are an assistance to him; but, in my opinion, something much more is required than an appliance of this kind, which, when forgotten to be used, as in this case, may be really an element of danger, by inducing a false sense of security.
>
> The view of the platforms from the signal cabin is so bad that, unless a new cabin be erected nearer to the station, it is necessary that there should be some control from the station over the entry of trains, either by means of a ground frame, or, better still, by the placing of treadles or bars on the several lines, and interlocking the signals with them. The whole of the signal arrangements, however, at this station require revision, some of the signals being obsolete in pattern, some of them being wrongly placed, and several sets of facing points being without the proper safety appliances, having neither locking-bar nor facing-point bolt.

We cannot ourselves see why it should not be possible to mark the presence of a train in such a position by electrical means. We feel quite certain that such could with ease be accomplished, and that in this, as in many other cases, if the traffic authorities would but make known to their electrical branch their requirements, they would obtain valuable aid in the prevention of such casualties.

At Hulton's siding, near Chequerbent, on the London and North-Western Railway, there occurred on January 20th a collision between a passenger train and a goods brake van and engine, which was standing on the down main line. Although there would appear to be some extenuating circumstances in the favour of the signalman, there would appear to be no question of the accident having been due to the manner in which he dealt with the two trains. Major Marindin thus concludes his report:—

> I must observe that this is an accident which, like the recent one near Thirsk on the North-Eastern Railway, would have been prevented by the use, in its complete form, of one of the "lock-and-block" systems, for the crossing of the engine and brake van on to the down line would have locked the block instrument for that line, and also the starting signal at Daubhill, until the line had been cleared by the passage of the engine and brake van into Hulton's siding.

Remarks in which we fully concur.

The interlocking of the electrical with the mechanical signals is undoubtedly a most important question, and the more our railway system becomes crowded with trains, the more urgent and the more important it becomes. At the same time it is a question which will undoubtedly involve a large outlay, and occupy in its establishment much time. We would suggest to the inspecting officers of the Board of Trade, and to the railway companies whether, in the meanwhile, something of a more simple character might not be done; for instance, in this as in the Thirsk, and in the Richmond case previously referred to, whether a simple means of indicating to the signalman the presence of a standing train cannot be found. We quite feel that with the aid of their electrical and permanent way engineers there should be a means of doing so; and we very heartily, in the interest of the travelling public, commend the subject to their consideration.

THE TRUMPY AUTOMATIC ACCUMULATOR REGULATOR.

IN our description of the Municipal Station at Berne, we mentioned an automatic regulator for accumulators, the working of which seemed faultless. Some of our readers having asked for further particulars of this apparatus, we (*L'Industrie Electrique*), think it will be worth while to give a detailed description of it. The preference shown at the present day in Germany and Switzerland for accumulators is due, not only to the improvements made in the accumulators themselves, but more especially to the reliable and simplified regulation ensured by instruments of this kind. Whether we simply use a battery in which the current is regulated by frequent variations of the motor, or whether we have to do with the storage of electrical energy, regulation is required at almost every moment. We can certainly effect this by hand, but there are cases, such, for instance, as the working of a battery during the night, after the works are closed, when a good regulator is required to keep up, *automatically*, a constant potential for the lamps. The Trumpy apparatus has for some years been employed in hundreds of installations. This

instrument is constructed either *single* or *double*, for currents of from 50 to 2,000 ampères, and with from 6 to 36 contacts.

Among the various component parts of the regulator, some, especially the relays, are the same for all current strengths; they are even manufactured as separate apparatus mounted on slate. The regulators are made both of a small and of a large

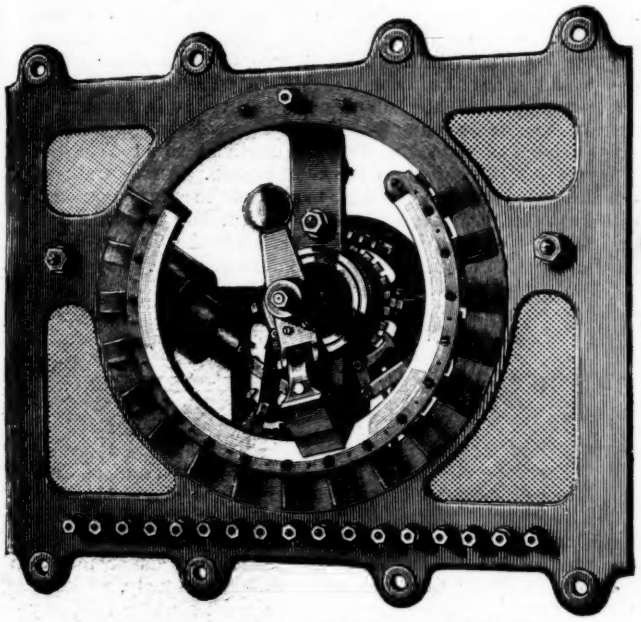

FIG. 1.—FRONT VIEW OF A SIMPLE AUTOMATIC REGULATOR.

size. The former have their contacts and disconnectors mounted together on slate. The motor, on the contrary is fixed on a cast-iron frame, which serves at the same time as a support to the slate. These instruments have a very pretty

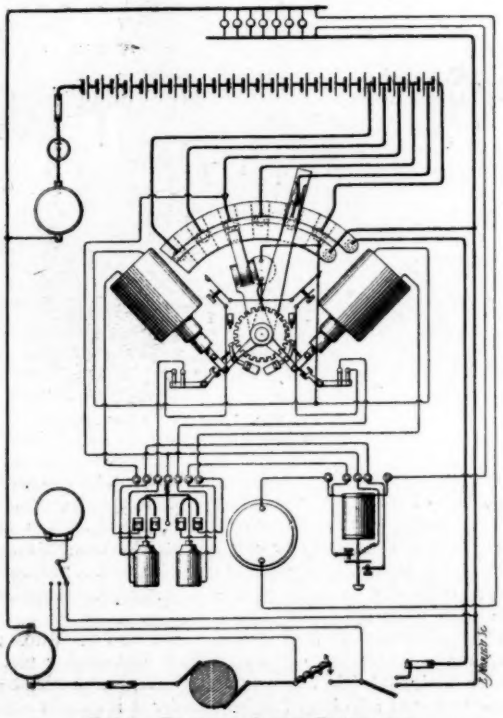

FIG. 2.—PLAN OF A SIMPLE REGULATOR.

appearance and are an ornament to the board. Care must be taken when they are fixed that they are left accessible from the back.

The *simple* automatic regulator is the one usually employed for small installations. The apparatus that regulates the cells is in one piece with the relay and commutator, and the whole is fixed on a wooden board, so that we have only to connect this board with the battery and with the terminals of the dynamo.

The *double* automatic regulator is also used in small installations, even when the cells used are few in number.

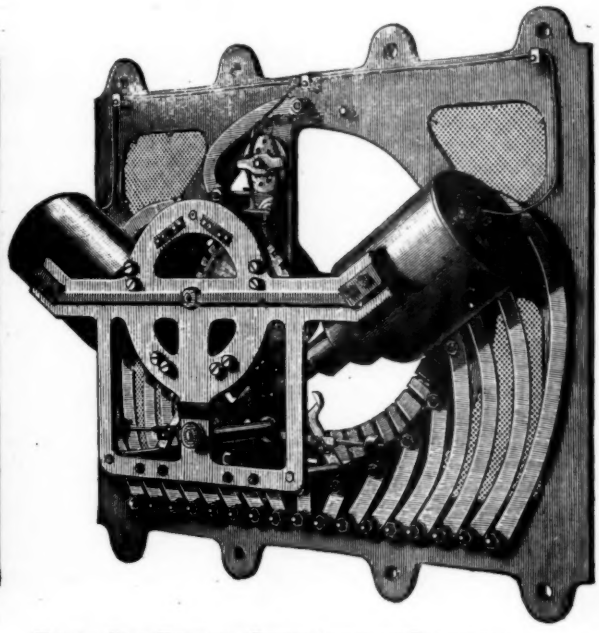

FIG. 3.—BACK VIEW OF A SIMPLE AUTOMATIC REGULATOR.

This apparatus is not more bulky than the other. Small brushes rubbing on the charging lever, and connected with a special voltmeter, enable the electromotive force of the cells under charge to be read at any moment, thus preventing any useless overcharge.

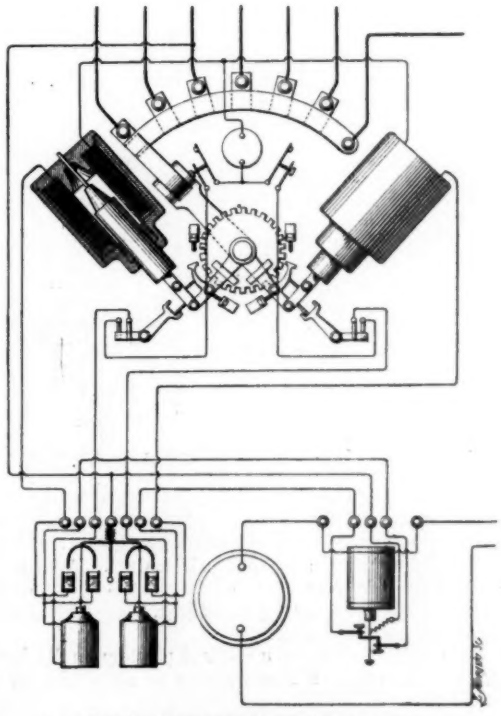

FIG. 4.—PLAN OF A SIMPLE REGULATOR.

The inner contact lever, which maintains a constant tension over the lighting system, is arranged to act automatically, but the charge lever is worked by the attendant, who observes the condition as to charge of the cell nearest to him.

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These little instruments are contained in a wooden box, which can easily be removed, in order to preserve them from dust and accidents. In instruments for strong currents a toothed brush is used to turn on the current. This firmly clutches the contacts and bars of each accumulator. The brush, which is of white metal, is provided with flexible teeth, which ensure a good permanent contact. Moreover, manipulation is rendered possible, even when the instrument is working, by means of secondary brushes in the double regulator. We thus avoid any interruption of the current, and any short-circuiting in the accumulators.

Figs. 1 and 3 represent the large single regulators used in the Berne works, for 16 accumulators and 225 amperes.

The mechanism automatically working the lever of the connector and disconnector is too bulky to allow of the apparatus being enclosed in a protecting box, which is, besides, less necessary in this instance. The parts are all easily accessible, so that it is always possible to clean and test the contacts. All the movable parts of the conducting portions can be examined, even while the apparatus is at work, without its being unmounted or stopped.

Figs. 2 and 4 show the principle of working of the Trumpy automatic regulator.

The lighting system, or the line charged, is connected with the relay. If the tension is insufficient, the free core of the relay is lowered and establishes communication with the lower screw. If, on the other hand, the tension is too high, the core rises and establishes contact with the upper screw. By this closing of the current, one of the electro-magnets of the commutator is excited, and, consequently, closes the circuit for one of the electro-magnets on the accumulator rod. This rod then attracts its core and draws up a fork. The stopping tooth that is engaged in the cog-wheel, consequently, puts in motion the contact lever fixed on its axle.

This displacement of the core corresponds exactly with the displacement of the contact lever from one element to another. When the core of the relay is quite insulated between its two contacts, the current is necessarily interrupted in the small electro-magnets, as well as in the circuit of the larger ones. If the core resumes its original position there is a fresh interruption in the excitation of the small magnet. And, in the case where the relay continues to work, that is if the tension has not yet arrived at the point desired, the same operation is reproduced, as previously shown.

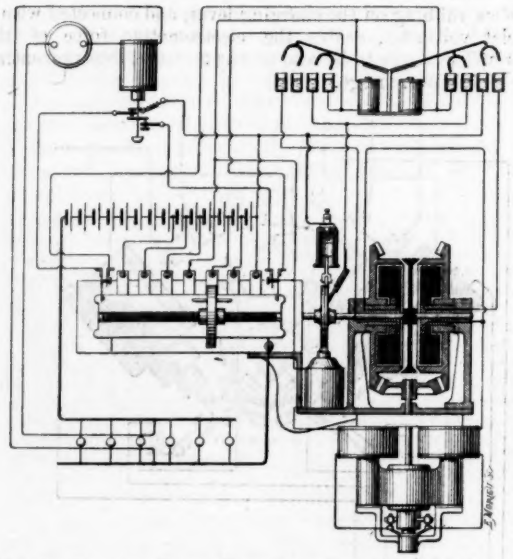


FIG. 5.—PLAN OF A LARGE REGULATOR, WITH ELECTRIC MOTOR.

If the contact lever takes up a fixed position on the bar of the accumulators there is also a closing of the circuit for the little magnet.

The mechanism acts with great promptness, so that the apparatus follows closely the most rapid variations in the charging current. The construction of this regulator not being at all complicated, requires very little supervision and attendance, consisting mainly in keeping the contact surfaces and the cores of the electro-magnets in good condition.

For the large regulators the construction is somewhat different (fig. 5). The relays and commutators are retained, but the electro-magnets are replaced by a motor which transmits its motion by a magnetic gearing to a worm wheel acting on the lever of the accumulator rod. The construction is so arranged that the motor can only be touched to be regulated, in order to avoid any useless waste of energy and all wear of the movable parts. The consumption of energy only takes place during the insignificant periods of the effective irregularities. In cases where several regulations are required (systems with 3 or 5 wires), a single motor would suffice for all the bridges. As we see, the attendance required is of the simplest kind. A certain number of French stations use batteries of accumulators for lighting during the night and stop the machines at 11 o'clock or midnight, according to the consumption. An apparatus of this kind is then required to decrease the tension automatically as the lamps are extinguished, and to increase it towards 5 o'clock in the morning, when the various works and factories begin to open, as is done at Berne.

NEW STANLEY-KELLY ALTERNATING MOTOR.

THIS motor is described in the *Electrical World* of New York, of April 29th. The description is of great length, although the novel points in the motor are very few. It is a two-phase motor, and therefore does not advance the important problems in regard to an alternating motor for the present supply circuits; given a two-phase supply, we know that many motors are ready for the market whose efficiency and general excellence are quite satisfactory. But no two-phase supplies exist either here or in America, and to convert an ordinary two-wire or three-wire system, supplying single-phase currents, into a two-phase system, means such a large outlay in new dynamos, new connections, and new wires, that no company would for a moment consider such a proposal as serious, especially as none of the existing plants are more than a few years old.

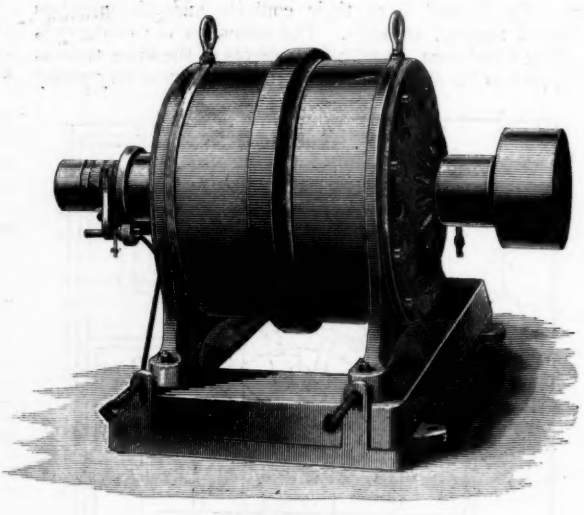


FIG. 1.

This motor has two field magnets and two armatures; in fact, is a combination of two distinct but similar motors, having laminated field magnets and drum-wound armatures, cross-connected into closed coils. So far it is exactly similar to Rankin Kennedy's two-phase motor, described by us in our issue of May 27th, 1892.

Stanley and Kelly have added to this motor condensers in shunt to the field, for the purpose of reducing the "Wattless" currents. They have also added a "compensating" winding on the field magnets; this winding, is designed, to act as a secondary to the armature coils, and

thereby acting, reduces the impedance of the armature circuits, and allows larger currents to circulate in them than would otherwise be the case. How far these coils "compensate" is a moot question; it is very likely they introduce greater magnetic resistance into the circuits, and cause distortion of the fields.

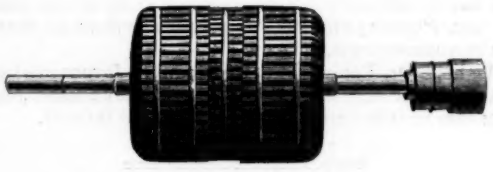


FIG. 2.

Fig. 1 shows an elevation of the Stanley-Kelly motor; the two fields are multipolar, and have inward projecting polar extensions; the commutator on the end is merely for inserting resistances into the circuits when starting.

FIG. 3.

Fig. 2 is the elevation, showing the two armatures on one shaft.

Fig. 3 is a view showing the armature cores in place.

From these figures the construction of the machine can be readily understood.

THE ELECTRIC LIGHTING OF ZNAIM.

[FROM OUR OWN CORRESPONDENT.]

THE town of Znaim, in Moravia, resolved some time ago both to supply electricity for public lighting, and place electric current at the disposal of private persons as well for lighting as for other purposes.

The realisation of this project was first conceived in the form of a concession to a contractor. Subsequently the question was raised whether it might not be preferable to erect and conduct the electrical works on municipal account, which appeared the more advantageous because the town had recently erected waterworks with which the electrical works might be combined. In this manner the electric installation would be much more economical, both in erection and management, than would independent electrical works.

A competition was now invited on behalf of the town, both for supplying electrical works and for the grant of a concession to a contractor.

Ten tenders were in consequence submitted, with the following result:—

1. Egger & Co., of Vienna, for street lighting, employing the steam engine at the waterworks, and an installation of accumulators. Total expense, 32,300 florins. Continuous current and aerial leads.

2. Deckert and Homolka, of Vienna, two projects, each for 12,000 lamps burning simultaneously. The cost for the first project with aerial leads equals 514,400 florins; the second project with underground leads and building expense equals 543,828 florins, without connection for private consumers.

Both projects propose a central station in the municipal wood market, on Mariahilfer St. (Continuous current.) The same firm propose a third project, extending merely to street lighting, utilising the waterworks. Aerial leads. Total cost, 12,000 florins. Continuous current.

3. Kremenzky, Mayer & Co., Vienna, three projects, all with continuous current: (*a*) joint installation for private and public lighting, central station in the municipal wood market, 300 public and 1,000 private lamps; (*b*) for public lighting only, 14,990 florins; (*c*) for private lighting only.

4. Crompton & Co., Limited, London, street lighting, and 600 glow lamps for private lighting. Continuous current, with use of the turbines and the steam engine at the waterworks, and accumulators. Building cost, 65,000 florins, without adaptation of the waterworks, foundations of machinery, &c.

5. Salzer, Probst & Co., Vienna, public lighting and 600 private lamps, use of the waterworks. Continuous current, with accumulators. Cost, 40,552 florins.

6. Ganz & Co., Vienna (a branch of the Budapest firm), employing the entire machinery of the waterworks, erection of a new steam engine and a new turbine, two projects:—

a. Street lighting and private lighting with 1,500 lamps. Cost 58,608 florins, without buildings.

b. Street lighting and private lighting for 1,800 lamps. Cost 77,927 florins, without buildings.

7. Siemens & Halske, Vienna, public lighting, and 1,400 lamps for private lighting. Central station at the wood market. Cost, 110,000 florins. Continuous current, accumulators.

8. Schuckert & Co., Nüremberg, public lighting, and 1,000 lamps for private lighting, accumulators, central station near the Upper Avenue; total cost with aerial leads, 147,295 marks; with underground leads, 182,195 marks, not including earth works and masonry.

In the above-mentioned projects it is assumed that the municipality carries out the working on its own account. Only Deckert and Homolka would undertake the working on their own account.

9. The International Electrical Company of Vienna offer, if the proposal of Ganz & Co. is carried out, to conclude an agreement for working it for 50 years.

10. Julius Rittler, of Znaim, offers, in his tender, to carry out the public lighting at his own responsibility on municipal account for from one to three years, and then to surrender it to the municipality. The installation would cost 118,000 florins.

Preliminary consultations were entered upon by the Town Council and the Lighting Committee, and it was resolved, before pronouncing for granting a concession to any undertaking, to submit the tenders for a central station for joint public and private lighting, especially those of Siemens and Halske and Ganz & Co., and the proposal of Julius Rittler, to a disinterested specialist, who is to determine, as early as possible whether it is for the interest of the town to undertake the installation and working of the electric lighting on its own account.

ELECTRICAL OSCILLATIONS OF LOW FREQUENCY AND THEIR RESONANCE.

THE sensitiveness of the telephone for exceedingly small alternating currents is well known: it is probably as great as that of the most delicate Thomson galvanometer for direct currents, and, like this instrument, is especially suited to zero-methods. But the telephone does not enjoy that popularity in the precision room which the direct current instrument has, although the field of physical research in which alternating currents must necessarily be employed is very extensive. The fault lies with our alternating currents and not with the telephone. The alternating currents which the ordinary induction coil, as employed in physical laboratories, produces, is far from being a simple harmonic current, and the consequence is that, in many cases, the zero method for which the telephone is specially suited has to be abandoned and the minimum method substituted for it; this is at best a poor substitution.

Dr. M. I. Pupin, of the School of Mines, Columbia College, U.S.A., has been engaged upon a research in which alternating currents had to be employed, and he has succeeded in devising a method of producing simple harmonic currents of constant frequency, the frequency being easily and accurately determinable; his account is dated March 9th, 1893. Although in this research he has practically covered some ground which had already been occupied by Mr. Nikola Tesla, independently, it will be interesting to consider his results and his method of arriving at them, especially since they present some new features and suggest an exceedingly

pregnant question which it is to be hoped will be fully investigated.

Dr. Pupin's earliest solution of the problem of producing alternating currents of constant, easily and accurately determinable frequency, consisted in producing such a current in the secondary of a very small transformer by making and breaking very rapidly, and at a constant rate, the primary; and the form of apparatus by means of which this was effected was shown to Profs. Abbe, Barker, Mendenhall, Michelson, and Rowland, during the autumn meeting of the National Academy of Sciences in New York in 1891, and was very favourably commented upon by these scientists. It was called an electro-dynamic interruptor. Since then experience has suggested modification. As now used, the instrument presents some interesting features, although Dr. Pupin admits that some of these were copied from Dr. Max Wien's magnetic interruptor *(vide Wiedemann's Annalen*, 1891 and 1892). These are described in great detail in Dr. Pupin's paper, which may be consulted in the *American Journal of Science*, Vol. xlv., April, 1893, pages 325—334, where illustrations in plan and in elevation may also be seen.

We may notice, however, that a special feature is the vibrator, a stout wire of aluminium or phosphor bronze, which is stretched between the pole-pieces of two permanent Weston magnets, such as this electrician uses in his voltmeters. This vibrator, when at work, gives a pure musical note when the tension has reached a certain limit in which the overtones are scarcely perceptible. Condensers are used in order to keep down sparking, and that peculiar rattling noise which is so full of those very high notes for which the telephone is especially sensitive.

The arrangement, to which we have thus alluded in general terms, produces a complex harmonic current which has to be reduced. This is effected by a process of weeding out the harmonics by electrical resonance. Dr. Pupin describes what he terms the "natural period" of the system employed and shows that by varying the capacity of the self-induction of the circuit this natural period may be varied. He calls this variation the *tuning of the electrical circuit*.

By tuning the circuit it can be brought within certain limits in resonance with any one of the harmonics, each harmonic being really a forced oscillation of the circuit.

A method is then described by which tuning is effected for the purpose of producing a high rise of potential at the condenser plates of the arrangement; and another method of tuning for the purpose of supplying a Wheatstone bridge with a simple harmonic current of constant frequency. In the latter case, the method of tuning is governed somewhat by the well-known conditions under which the flow in a Wheatstone bridge system will have the highest sensitiveness. These conditions exclude the possibility of using self-inductions which are very much larger than those in the principal branches of the bridge. Two kinds of apparatus may be employed, the first, and in many respects the most convenient form is the electro-dynamic interruptor which has already been alluded to. In describing the application of this method, Dr. Pupin italicises the following sentence:—"It is needless to observe that the upper harmonics which the vibrator tends to produce are completely wiped out in the telephone circuit, and that, therefore, with this arrangement we can employ the zero-method of measurement, using as our detector the ordinary Bell telephone."

The second kind of apparatus that can be employed is a coil in series with a condenser. A spark space is inserted in the circuit between the coil and the condenser, and the extremities of this spark space are connected to the poles of an influence machine, or a high voltage electro-magnetic generator, and an air blast is applied to the spark space where the sparks begin to pass. An alternating current of any frequency may thus be generated in this coil-condenser circuit by a proper adjustment of capacity and self-induction and by gradual transformation and tuning deprived of all its upper harmonics. This method is most suitable when a simple harmonic current of definite frequency is desired to drive a synchronous alternating current motor, that is to say, a simple harmonic current carrying with it a large quantity of power.

It is here that Tesla has already covered the ground. This scientist obtained a patent about a year ago on the method of generating alternating currents of any frequency by means of disruptive discharges, and it must naturally be rather disappointing to Dr. Pupin that he has been anticipated in so pretty an invention. He consoles himself, however, with the thought that a method patented by so excellent an experimentalist as Mr. Tesla, would enable him to obtain his object, namely, to *construct a synchronous alternating current motor which would spin around with great but perfectly constant angular velocity, the angular velocity to be just as adjustable and just as accurately determinable as the time of vibration of his (Dr. Pupin's) vibrator, the motor to perform the function of a microphonograph.*

We hope Dr. Pupin will be able to give a favourable report on this matter very soon, and shall await any further results from him in this direction with the greatest interest.

TELEPHONE COMPANIES AND ELECTRIC TRACTION.

SUMMARY OF EVIDENCE.

The Lords and Commons Committee which is considering the question of the metallic return, for the whole matter really relates to this, has before it the most important enquiry which has been held on electrical subjects since the electric light enquiry of 1888.

We will not without the whole of the evidence before us stop to review it. A brief summary of the evidence is, as follows:—Sir Courtenay Boyle showed the position of the telephone and traction companies to one another. Mr. Preece, who was the first technical witness called, said: The first telephone fixed in London was worked on a metallic circuit, and ever since the Post Office had used the metallic return; but the telephone companies on the other hand had used in their town systems the earth as a return. The effect of leakage and induction from the South London Railway was most marked on the Post Office telegraph circuits. Whenever a train was started leakage currents had been noticed as far away as North Walsham, in Norfolk. Mr. Preece then described the effects of leakage currents from railways, such as lowering the arm of a block signal. He considered that if London were perforated with electric railways, the matter of leakage would become serious. With proper supervision, however, he thought it possible for every tramway in England to use the earth accidentally, without doing harm.

Mr. W. E. L. Gaine, the general manager of the National Telephone Company, gave a good many details of the number of messages and cost in various towns of the National Telephone Company's system. Berlin was the largest telephone system in the world, and the earth circuit was adopted. The witness said that the National Telephone Company had spent large sums in adopting the metallic circuit in London; the return wire, in his opinion, was absolutely valueless to the company commercially. He gave some astounding figures as to the cost of the return circuit. Taking Liverpool as an instance, the witness declared that it would cost £20,000 for a switchboard alone. Assuming the alarming hypothesis that electric traction were adopted throughout the country without using a metallic return, it would cost the National Telephone Company £2,000,000 to protect their system. The company had already spent £100,000 in the London district in changing from the earth to the metallic system. The witness admitted, however, that the Postmaster-General had said that he would give no more licenses to telephone companies unless they used the metallic return. In his estimation a complete metallic circuit system in London would cost £250,000, and it would take five or six years to arrange it.

Dr. John Hopkinson spoke of the disturbance caused to the telephone system at Leeds by the electric tramway. His experience of the London telephones was that there was no disturbance. (This is a unique experience.) He considered that only slight complications would be added if tramway companies were obliged to use two conductors.

Lord Kelvin followed, and said there would be no practical difficulty in having return conductors in either an overhead or an underground system. Two insulated conductors would allow of a much higher working pressure, and would very much diminish the quantity of metal used in the conductors.

The following is a full report of the proceedings up to Wednesday night:—

THE Joint Committee of the Houses of Lords and Commons appointed to consider the course of procedure in relation to the arrangement of protective clauses for telephone and other companies against the operations of electric railways and tramways, sat on Monday for the first time, for the purpose of receiving evidence. Viscount Cross, the chairman, presided. The following are the members of the committee:—Lord Rosse, Lord Russell, Lord Clifford of Chudleigh, Lord Kerr, Sir Bernard Samuelson, Mr. Brunner, Mr. Forwood, Major Darwin, and Mr. Molloy.

Counsel representing the Railways Association, the National Telephone Company, various electric tramways and railways, electric lighting companies, the County Council, the Leeds Corporation and other municipalities of England and Scotland, and Mr. Hunter, solicitor to the General Post Office, were in attendance.

SIR COURTENAY BOYLE'S EVIDENCE.

Sir COURTENAY BOYLE, K.C.B., Permanent Secretary to the Board of Trade, said that for several years the telephone, and also the telegraph companies had been asking for protective clauses in Electric Lighting Provisional Orders, and in Tramway Bills, with a view to avoid interference with their circuits. The telephone and telegraph companies used as a general rule the earth for the return current, though in some sections of the telephone system of the General Post Office there was a metallic return. The action of Parliament had not been uniform, and the effect of different clauses had been to give varying degrees of protection to the telephone companies. It was desirable that the question should be settled, and that there should be a sort of model clause. The Board of Trade found that the telephone companies were again pressing this session for protection. After a meeting held at the Board of Trade a representation was made to the chairman of both Houses by the Board of Trade that it was desirable that Parliament should lay down the principle governing the amount of prohibition, if any, to which the telephone and telegraph companies were entitled. The telephone and telegraph companies used very small currents at a very low pressure. In the case of the telephone it was something like a millionth part of an ampère, and the pressure was a fraction of a volt. The electric lighting companies used a current of something like 100 to 5,000 ampères at a pressure of 10,000 volts. The current used by electric lighting and electric tramway companies would be very high indeed. It was a case of the wolf and the lamb, and it was desirable to protect the lamb from the wolf. The current used in lighting and in the case of tramways affected the telephone and telegraph companies, generally speaking, by leakage. Efforts were made to prevent leakage by the tramway companies. They tried to confine the current within its circuit, and to prevent earthing, but it had been found very difficult to accomplish this. In the case of the City and South London subway it had been found impossible to prevent leakage of the current to the earth. When earthing took place electrical disturbance was set up which might extend to a considerable distance. The disturbance followed the mathematical law, and the effect varied inversely as the square of the distance, and this disturbance caused a material interference with the very delicate sensitive instruments used by the telephone and telegraph companies. Leakage was owing to the installation not being sufficiently protected. In some of the systems a metallic return circuit was used, but the telephone companies pleaded not to be placed under the obligation of making, at a very considerable expense, this metallic return over the whole of their systems. The tramway companies asked why the earth should belong entirely to the telephone companies. The Board of Trade in electric lighting absolutely forbade the use of earth return circuits, and in the case of tramway companies an endeavour was made to prevent leakage, but it was not absolutely possible to do so. Electric traction was growing in popularity, and it would grow yet more if this question could be settled. If the electric companies were to be under heavy penalties; if, by accident, leakage took place, they would not be bold enough to attempt it. A case had come before Mr. Justice Kekewich recently, which was known as the Leeds case, where the National Telephone Company were the plaintiffs, and the Leeds Corporation the defendants, and it was clearly shown that the company were harmed by the action of the corporation in using electrical traction, but the judge's decision was not in favour of the plaintiffs. There were instances in which there had been material interference with the telephone instruments of the Post Office. At Preston, where the electric lighting companies' conductors were not sufficiently protected from earthing, arcing had taken place, and certainly gas and water pipes had been materially injured, and a very serious accident was narrowly avoided; the water pipes were eaten away by electrolytic agency. In another instance, in the South of England, serious disturbance was set up by the leakage. The telephone companies could make themselves absolutely safe by using a metallic circuit, and the tramway companies argued that, as they could not protect themselves against possible leakage on occasions, they ought not to be under very heavy liabilities by user of the earth which should be free to all. The telephone companies replied that they did no harm by using the earth, and that they could not hurt the lighting and tramway companies. They therefore asked to be allowed to continue to use it. The traction companies replied: "No; if you use the earth at all, we are entitled to do so also, or else nobody must use the earth at all."

Mr. FORWOOD: Would the use of the earth as a return circuit give as good a result, so far as hearing is concerned, in the case of the telephones, as would a metallic circuit?

Sir COURTENAY BOYLE said that when the earth was used as the return circuit for telephoning, it must follow that there was a certain amount of electrical disturbance. Perfect telephoning would be accomplished by a metallic circuit, and not by an earth return. The number of tramway companies using electric traction was very small, and the electric lighting companies were forbidden to use earth, but if sanction was given to electricity for traction, the number of instances in which there would be danger would grow.

By LORD RUSSELL: The argument was, that the expense of making a metallic return in the case of the telephone companies would be much less than in the case of the tramway companies. The tramway companies urged that they had done a very great deal to protect their systems absolutely from danger, but it would not cost the telephone companies very much to protect themselves. On the other hand, the telephone companies said they had established a large and far-reaching system, and they did not see why they should be obliged to alter it. The powers now asked for were sought both on the ground of safety and to protect other circuits. Earthing was a mischievous thing from any point of view. There was no railway or tramway company which deliberately made use of earthing; it was the result of accident. It was extremely difficult to prevent earthing under some circumstances.

Mr. HUNTER remarked that the Post Office had no grievance against the tramway or electric lighting companies, because they considered they were sufficiently protected at present.

MR. PREECE'S EVIDENCE.

Mr. PREECE, Engineer-in-Chief and Electrician at the General Post Office, President of the Institute of Electrical Engineers, said he had been forced to give attention to this subject, because the Post Office had found their telephones and telegraphs gradually becoming disturbed. The disturbance arose from two causes; first, the passage of currents of electricity through the crust of the earth; and secondly, what was commonly called induction, but which was now explained to be due to the passage of the electric waves through the ether which filled space and of course was in the air. The currents through the earth were the most serious; the disturbances due to induction were easily remediable. The earth had from the very earliest days of electricity, 1837, been used for the return half-circuit of the telegraph. In London, a wire was usually attached to the water and gas-pipe system, and there made contact with the earth. The very first telephone that was fixed in London was fixed on a metallic circuit, both wires being insulated, and ever since the Post Office had invariably used metallic circuits. The Telephone Companies on the other hand in their town systems used the earth, but on their trunk lines they used metallic circuits. On railways, where the telegraph was used for the regulation of traffic and electric signals, the earth was used; in fact, at the present moment the earth was used universally for telegraphs, almost universally for block signals, and very largely indeed for telephones, but not for the Post Office telephones. The Electric Light Provisional Orders, Clause 9, sec. 3, said the undertakers should not use earthing unless approved by the Board of Trade. The City and South London Railway had started working in 1890. It extended from the Monument to Stockwell, and had a central station at Stockwell. It did not designedly use the earth. The return circuit was made by means of the rails and also by the iron tubes which formed the tunnels through which the trains ran, which picked up some of the return circuits. The current passed from a central line through the motor and on through the wheels of the locomotive to the metals and ought then to go back, but it did not. The leakage currents whenever a train was started extended to such a distance that they had disturbed the observatory instruments at Greenwich, and had been noticed as far as North Walsham, in Norfolk. A part of the Norfolk circuit in connection with the Post Office had been observed, and the currents were found to rise and fall exactly with the movements of the trains. Whenever the train service ceased for the night, the disturbances at Greenwich and at the Post Office ceased at the same time. The observations at Greenwich and at the Post Office tallied. In Clapham-road, a chemist had in his shop window an instrument that recorded the passing of every train. It was simply connected on the one side to the gas pipes, and on the other to the water pipes in his house. It was found that the leakage between Stockwell and the city sometimes reached 3 volts, currents forced through the earth at a pressure of 3 volts, and the pressure between the gas and water pipes in this case was ·3 volts, producing a current of nearly half an ampère, the leakage being sufficient to ring an electric bell. The effect of these disturbances to the water or gas pipe, whichever was connected with the positive side current, would in course of time be to decompose them away. Leakage was a great source of danger to the railway companies in respect of their block signals. In 1880, for instance, the London and North Western Railway lighted the harbour at Holyhead with electricity, using five arc lamps with five dynamos, and the first effect was to break up their block signals, but this had been completely cured by making a metallic circuit in the case of the signals. The effect of earth currents had been as follows: the moment a train stopped there was a great rush of electricity to stop it, and part of the current was sent round the earth, and the block signal was lowered, and there was serious danger; but it could be remedied by a metallic return. As a rule, the block circuits only extended from half-a-mile to a mile, and it would only mean putting a second wire from the block signals likely to be affected. In the case of the Liverpool Overhead Railway, the metals were planted on continuous wooden sleepers and not much earth was made, so that the currents were much less than in the case of the City and South London Railway, which was only partially insulated. He had not yet heard of any actual disturbance of a block signal or a telephone in South London, but if all London was to be perforated with electric railways, as was anticipated, the injury was almost certain to arrive. At Blackpool, the escaping current which lowered the railway signal also fired the time gun, and the time ball had been lowered a minute or two before its time by the currents from the electric tramway. In the case of tramways it was certainly difficult to find a remedy, and his view was that the use of earth by railways and tramways should be subject to the approval of the Board of Trade, with the concurrence of the Postmaster-General, as in the case of the electric lighting companies, but he did not say that the use of the earth should be prohibited. In America they had used the earth a great deal, but when it was found that the telephones were being disturbed, they did all they could to

use metals. There would be no difficulty in virtually insulating the metals in an iron tube, such as that of the City and South London Railway. The leakage was increased, he thought, because the joints of the tube and of the metals were rusting. In the South London Railway, the chairs which carried the metals in some cases touched the iron tube. This accidental use of the earth must mean a very considerable waste of electrical energy, and the working expenses at the central station must be increased greatly. The disturbances had increased from 1891 to 1893 so as to attract his attention, and this was probably due to the rusting of the joints in the metals and the tube, as he had stated. He thought that if the metals rested on continuous wooden sleepers any injurious effect would be prevented. The Post Office used a metallic return for the telephones, but for the telegraphs earth was absolutely necessary. If metallic returns were used, the cost of maintenance would be doubled. The Post Office had had no experience at present of any disturbance of the telegraphs, but it was anticipated that by the extension of the electric motive power the telegraphs would be disturbed. With proper supervision, he thought it possible for every tramway in England to use the earth accidentally without doing harm. The Post Office had about 7,000 telephones, and were now erecting 4,000 to 5,000 miles of line, and he thought they had, at present, perhaps 20,000 miles of telephone line. Alternating currents would not affect gas and water pipes. Continuous currents could do so, but the disturbing effects could be materially reduced by placing the whole water and gas system in connection with the return system. In some remote districts in Ireland the Post Office used earth return, but, in these cases, it did not interfere with anything else. In all other cases they had metallic circuit.

SECOND DAY.

The Committee sat again on Tuesday, the Chairman presiding.

At the suggestion of the CHAIRMAN, the various interests represented were stated to be as follows: National Telephone Company, Mr. Pember, Q.C., and Mr. Wallace. Railway Companies, Mr. Pope, Q.C., Mr. Fletcher Moulton, Q.C., and Mr. Ernest Moon. Electric Tramway Companies and Electric Uunderground Railway Companies, Mr. C. A. Cripps, Q.C., Mr. J. C. Graham, Q.C. The Electric Lighting Companies were not represented by counsel. Municipal Corporations of England and Scotland, Mr. Balfour Browne, Q.C., and Mr. Worsley Taylor, Q.C. Tramway Institute of Great Britain and Ireland, Mr. Hans Hamilton. Mr. Hunter, solicitor to the General Post Office, represented the Postmaster-General. The London County Council were not appearing, but had sent a memorandum to the committee.

NATIONAL TELEPHONE COMPANY.

Mr. W. E. L. GAINE, examined by Mr. PEMBER, said he was general manager to the National Telephone Company. The license from the Post Office, under which the company worked, dated from November 29th, 1884, and was for 31 years, so that it would expire in December, 1912. It extended through the whole of the United Kingdom. It was a very much cheaper and much more extended, and, he thought, very much better service than that of the G.P.O. The estimated annual number of calls was 109,339,220, the estimated number of messages 218,678,440, the annual value of exchange revenue and fees at April 30th was £554,171, the average cost per message was ·608 of a penny, total number of exchanges, April 30th, 506; number of exchange and private lines 60,155, and total mileage of wires on same date 90,746. The estimated yearly number of messages between Manchester and Liverpool was 295,200, at an average cost of 3d. per message; Newcastle and Sunderland 233,472, at 1·27d.; Leeds and Bradford 189,696, at 1·14d.; Edinburgh and Glasgow 108,552, at 2·65d.; London and Liverpool 48,024, at 1/5·57d. The whole of the exchanges, with one or two exceptions, had been built up on the earth-circuit system, which was adopted in nearly every country, the United States, France, Germany, and so on. The largest telephonic system in any one town was that of Berlin, with 17,000 subscribers, and it was entirely on the earth-circuit system. It was in the hands of the German Government. The earth circuit system was amply sufficient for all commercial purposes locally, but for long distances metallic circuits were provided. Universal metallic circuits would not pay commercially. The company had spent large sums in adding to the metallic circuits in London, where their area was no less than 500 square miles, with 23 exchanges. Here the metallic current was undoubtedly an aid to an efficient service. In Liverpool there was a local service with earth return, and also a vast number of subscribers who paid enhanced prices for long distance telephones. The company had 3,500 overhead wires in London. From the experience of the company, the return wires were absolutely valueless for commercial purposes. The duplicating of the wires would mean re-erecting the entire system, and if the Leeds tramway were planted in Liverpool to-morrow, Liverpool would be deprived of the company's telephonic system for five or six years, the time which would be required to effect the alteration. The switchboard for the exchange in Liverpool would not cost less than £20,000, and that did not take into account the cost of duplicating the wires, the enormous cost of maintenance, and of extra wages, repairs, and so on, and the re-duplication of the wires overhead across the town. The number of calls in one day on the central exchange at Liverpool were 24,000, which meant 88,000 telegrams passing through the exchange. It would be an inexpressible deprivation to the commercial community of Liverpool if the telephone service were put a stop to for several years. It was not a case merely of the duplication of all the wires, but it meant the re-arrangement of the entire system. Assuming that electric traction was universal throughout the country, and that the company had to do this, he estimated the cost to the company would be not less than £2,000,000. If the traction companies were prepared to pay the cost, he did not object.

Mr. CRIPPS, Q.C., representing the electric traction interests, cross-examined the WITNESS, who said that metallic circuits were used at Newcastle-on-Tyne and Hull, the reason being that nearly all the lines were underground. The charges were the same as where the earth system was used. The company did not charge more in London, where they had the metallic circuit, than they had done when using earth. The company had spent £100,000 in the London district in changing from the earth to the metallic system. The charges in Paris, where the metallic system was in force, were about the same as in London, but there the telephones were in the hands of the Government, who had nothing to pay for way-leaves and so on. No doubt, as the system had grown in London, the earth return had not given as efficient a service as the subscribers were entitled to. London presented a different problem to every other town, owing to its enormous area and population, and the great number of exchanges. In America there was a system of first, second and third class, and long distances or even moderate distances were in the first class, and had a metallic current, and the charge in New York was about £40.

In reply to Mr. BALFOUR BROWNE, representing the Municipal Corporations, the WITNESS said that in Walsall, where the tramways were worked by electricity, there had been complaints of interference with the telephones. He was not aware that the Corporation there had said they would rather give up the telephones than the traction. It was very likely this had been the case at Blackpool, because it was a seaside town and the tramways would be more in demand. The Corporation there had a private telephonic system, but the only persons entitled to give exchange services in the country was the National Telephone Company, under the license of the Postmaster-General, and he put it that the company were really performing a part of the service of the state. He was aware the Postmaster-General had given notice that no further licenses would be granted to any telephone company unless they used a return metallic circuit. The company competed with the Post Office at Newcastle, Cardiff, Hull, Leicester, and in several more cases, but competition was evidently not profitable to the Post Office, which had ceased to compete. Thirteen telephone companies in all had been licensed by the Post Office. He estimated that the cost of making a complete metallic return in London would be something like £250,000.

By Mr. PEMBER: He could not say whether the Paris telephones were worked at a profit or otherwise. They had to pay no royalty. The Government received something like £55,000 a year, 10 per cent. on the gross receipts, from exchange business.

By the CHAIRMAN: It would take at least three years to complete the alterations to metallic return in London, and a considerable amount of work had been done during the last two years. There had been considerable disturbance with the working of the system in carrying out this alteration.

By Mr. FORWOOD: If the telephone system was to be disturbed by the construction of electric tramways, the working of the telephones would be put a stop to for years. If the company had four or five years' notice the alteration could be carried out without much disturbance, but the question of cost was very material.

By Mr. MOLLOY: In the case of Liverpool, where everything was concentrated on one exchange, the metallic return was not necessary. When the whole system had been altered to metallic circuit in London, electric traction would not interfere with them if carried out properly.

DR. JOHN HOPKINSON.

Dr. JOHN HOPKINSON, F.R.S., in answer to Mr. WALLACE, said the electric lighting companies were required to use metallic circuits, and their wires caused no disturbance, except by accidental leakage. For electric lighting a power of about 100 volts was required; for tramway working 300, and railways 500. He had tried experiments as to the disturbance caused by the tramway at Leeds in connection with the telephone. There was a noise which rose and fell with varying pitch. It was quite intolerable. The car could be heard to start, and in some cases it could be heard distinctly that there were two cars running. The noise would prevent the working of the telephone upon the single-wire system. He had had experience of the London system of telephoning, and knew of no disturbances. There were many ways in which the tramway companies could convey the currents, that most employed being by overhead conductors, such as was the case in Leeds. No doubt a slight additional complication would be introduced by using two conductors instead of one, but some advantages would result; the electric pressure, for instance, could be doubled, and if that were allowed the capital outlay would be diminished, and also the running charge, to a certain extent. If they made use of two conductors, both insulated, and contact with earth ensued, the people in charge of the station would at once become aware that something was wrong, and would put it right before any injurious consequence had resulted. Nothing could hurt the public until there was earth contact. He had been to Buda Pesth, where there was 11 kilometres of double line tramway. The conductors were laid underground beneath the rail—there was no third line. The telephone system was entirely by earth return, and there was no disturbance. The conductors for the tramline were upon porcelain insulators. There were careful arrangements at the central station for giving information of any accidental contact with the earth. Such a system could, without doubt, be worked to the profit of the shareholders. There was a slot through which the electric current was derived. It was an inch and a third wide, but one not more than three-quarters of an inch would have been sufficient.

By Mr. MOON: The current necessary for working block signals would not exceed a fraction of an ampère—an ordinary telegraph current. At Blackpool a line had been erected specially to determine the extent to which the block signals were affected by the electric tramway, and it was found that the bell was rung and the signal pulled down to safety without any action on the part of the signalman, and that the next signalman could not tell whether it had been done intentionally or not. The remedy was to be found in the insulation of the return circuit of the tramway.

The voltage used by the block signals was perfectly harmless to any other interest.

By Mr. WALLACE: The effect of the current from electric lighting and tramways going to earth on gas and water pipes was a matter of very common observation, both here and in America. The pipes became oxidised, and this was a source of very serious danger. It would take thousands of years for the telephones to bring about such a result.

By Mr. BROWNE: Metallic return on the block signals would cure the tramway disturbances. The Board of Trade had put the electric light companies under obligations to cut off any consumer in whose house the insulation resistance was less than 5,000 ohms. The line at Buda-Pesth cost to equip about £4,000 per statute mile, including the rails for the cars to run on.

By Mr. CRIPPS: He did not defend the overhead system, but would have underground conduits with slots, unless the accumulator system came forward. He would not advocate it as it was at present. In the case of the slot system snow might create a difficulty, but it could be removed, and snow was always a trouble to the electrician. He would prefer to insulate the tramway system, but if it was still felt there was danger, he would insulate the railway block system too. The insulating system of parallel wires would practically get rid of induction. The telephones would get greater disturbance from induction than from leakage. If the tramway companies insulated both their conductors and made arrangements for detecting leakage, then the block signals would be safe. Before any danger arose the tramway officials would have noticed the leakage, and prevented it before a second leakage had occurred, without which there could be no danger. There could also be the additional security of making the earthing at once known to the railway company. The system of the South London Railway had worked very satisfactorily.

Mr. POPE made application that the gas companies should be allowed to be represented. Mr. Preece had made such serious statements with reference to the use of the gas and water pipes for the return current, that this was necessary.

Later in the sitting the CHAIRMAN intimated that the gas and water companies might be represented.

By Mr. HANS HAMILTON, on behalf of the Tramways Institute, Dr. HOPKINSON said he would not object to the use of accumulators if they could be made commercially successful. So long as the telephone companies had no right of taking up the ground to lay wires they must go overhead, and he would object to have the number of wires doubled, which would be the case if they were compelled to have metallic returns.

DR. EDWARD HOPKINSON.

Dr. EDWARD HOPKINSON, managing director of Messrs. Mather and Platt, Limited, said his firm had furnished the plant for the City and South London Railway. He estimated the cost of construction of a tramway three miles long, not including the buildings and the actual rails, to be as follows:—Rail return, £14,251; without insulated return, £12,698; insulated return, £14,665; and his company would accept tenders at these rates.

By Mr. CRIPPS: These estimates were on the basis of overhead wires.

LORD KELVIN.

LORD KELVIN, examined by Mr. PEMBER, said the escaping currents from electric light lines affected telephones perceptibly at a distance of five miles, and considerably for many hundreds of yards. He had examined the Blackpool Tramway very carefully, and the generating station. The return circuit was through the wheels and by the rails. The potential was about 300 volts, and there was very great disturbance. It was almost impossible to speak over the telephones at certain times during the running of the trams. He attributed it partly to leakage and partly to induction. The multiplication of contacts on the line would probably diminish the disturbance, and that could be effected without much expense. Two or three trollies instead of one would diminish the disturbance very much, and probably something in the way of brush contact would have the same effect, but the best method of preventing the disturbance would be a properly insulated return wire. There would be no practical difficulty in laying this, whether the wires were overhead or underground. Two insulated conductors would allow a much higher working electric pressure to be used, and would diminish very much the quantity of metal used in the conductors. Accumulators were to be preferred in some respects, but there was the difficulty of weight and expense, and no one could say whether they would or would not be used in the future. It would be a very great evil to the public if the number of overhead wires were doubled. If the tramways used the earth for the return circuit, it would be rendered unavailable to everybody else.

By Mr. CRIPPS: He did not think the use of the earth by the telephone companies should be interfered with, it was so valuable. The public required protection to prevent the gas and water pipes being utilised for powerful currents, such as those of the electric lighting companies.

By LORD RUSSELL: He thought there was a prospect of the successful use of accumulators. The cost was too great at present, but he thought it worthy of consideration.

THIRD DAY.

The Committee sat again on Wednesday, the chairman presiding.

NATIONAL TELEPHONE COMPANY'S ELECTRICIAN.

Mr. D. SINCLAIR, electrician-in-chief to the National Telephone Company, examined by Mr. MOULTON, said he had superintended the construction of the entire telephone system at Glasgow, which had 4,000 subscribers. The local wires were on the earth system. The service in London was not so good, because London was really a series of towns connected together. The London service was better than that of Paris, and as good as that of Berlin. At Leeds, owing to the disturbance, the company had obtained an estimate for making metallic circuits, and for 26 subscribers the sum amounted for outside work alone to £674. It would be necessary to duplicate the whole of the wires with the exception of not more than 10 per cent. The alteration was being carried out in Leeds because it was a small exchange, but at Liverpool the circumstances were such as to render it impossible. There were 3,500 wires in Liverpool, and to duplicate them would mean an entire new system of standards, and the work would take them from 5 to 6 years. They could not work on mixed systems, so that the duplicate wires would have to remain idle until the entire change had been effected.

Cross-examined by Mr. CRIPPS: He said that in Glasgow to a limited extent the company used the same exchange for metallic and earth returns. At Stockholm they had mixed exchanges, but there was very considerable difficulty in working them, which bore out his point, that when it became necessary to have metallic circuits, it must be completely metallic. The alterations in London, which were in progress, had caused numerous faults, and great many complaints had been received. The only proper way of working an exchange was on the multiple system, and the largest exchange he had seen so operated was 6,000, every contact being within reach of each operator. A mixture of systems would be productive of very great difficulty. In London the company used the earth return and the water pipe return.

Re-examined by Mr. PEMBER: He agreed that the estimate for a new switchboard for Liverpool of £20,000, was correct, and as there were a great many more exchanges in London, the cost would of course be heavier.

By Lord CLIFFORD: A good switchboard should last 12 or 15 years, except the cords, which would require to be renewed.

By Mr. MOLLOY: If the company had powers to put their wires underground they could deal with the question, because it would be simply a matter of cost. The overhead wires formed one for the main difficulties, as the company had no right of fixing them, but had to make arrangements with house owners. In the event of the traction system being largely increased in London, it would seriously increase the company's difficulties, the subscribers would not be able to use the telephones at all, and the same thing would be true whilst the company was reconstructing the system. This had been the case in Leeds. The leakage in connection with the City and South London Railway was so small, owing to the return by the tube, that it had not given trouble, at least, since the tubes had been metallically connected on the completion of the work; but what would be an absolute preventive of leakage in one soil would be death to the telephone in another. Whether a large increase of similar railways would affect the telephone would depend upon local difficulties—difficulties of the soil. In the cases of a tube in sand and another in clay, the results would be different as to telephone disturbances.

By Mr. FORWOOD: If the telephone company had rights under the road, it would immensely facilitate the extension of their work. It would be a benefit to the subscribers and to the public. The tendency would then be to take all the overhead wires underground.

Re-examined by Mr. WALLACE: The alterations necessary to make a metallic return would be of such a nature that the old switchboards would be useless.

SIR FREDERICK BRAMWELL.

Sir FREDERICK BRAMWELL, examined by Mr. WALLACE, said the exercise of the telephonic industry was absolutely without injury to any other interest whatever. The electric lighting companies distributed energy principally for lighting, but to a small extent for power purposes, such as electric lifts. The return was absolutely by metallic circuit. He had visited the telephone company's exchange at Leeds on a dry day, and had found that the disturbance arising from the tramway was intolerable. Half the words sent over the line were lost. At the Roundhay call office the disturbance was absolutely unbearable, and when the cars ceased running it ceased at once. The curing the evil on the part of the tramway company could only be a matter of expense which, compared with the whole cost of the line, would be an extremely small percentage, and, compared with duplicating the telephones, was not to be regarded. He knew of no mechanical difficulties in the way of the tramway company. With a small expenditure of capital, the Liverpool Tramway could have a better plant, and the benefits in the working would go a long way towards, if they would not entirely annul, the extra expense.

Cross-examined by Mr. BROWNE: The disturbance at Leeds was due to induction or leakage, or both. He thought the electric lighting companies would have used metallic return without being compelled by the Board of Trade, because they could not work efficiently without it. On the other hand, the tramway companies could get a large amount of the electricity back, because of the rails and the copper wire.

By Mr. CRIPPS: The electric lighting companies supplied power to a very small extent indeed. If the Telephone Company were treated in the same way as the Post Office they would have the protection they wanted. They were the licensees of the Post Office, and paid them 10 per cent. of their gross receipts.

By Mr. MOLLOY: Assuming that the tramway companies had a properly insulated metallic return, and that return leaked accidentally, the question as to whether it would be as injurious to telephones as the City and South London Railway, would depend very largely on the extent of the leakage. His opinion with regard to the City and South London Railway was that it should not be looked upon as an absolute earth return. It was nothing like the instance of the Leeds tramway.

By Lord ROSSE: In an overhead system such as that at Leeds the extra cost of the metallic return would be only that of the one return wire, and it would save the wire between the rails. The outgoing wire was $\frac{1}{10}$ths of an inch in diameter. If they had the best

system it would be the two wires in a tube underground. This would save the overhead work, and the extra expense of the entire return could only be a very small percentage on the entire outlay. He would put it at about 6 per cent. It would be perfectly feasible to increase the voltage if the return wire were used, and so the size of the wires could be decreased, and therefore there might be no extra cost at all.

By the CHAIRMAN: The metallic return in the case of tramways would avoid any accident to gas pipes. Assuming that the telephone companies were told that if they wanted protection they must provide it themselves by doubling their circuit, and the tramway companies were told they might send their circuit by earth, then if some accident happened to the telephone return circuit, the telephone would not be protected; whereas, if the tramway companies committed a nuisance, they were protected.

TELEPHONE COMPANY'S SOLICITOR.

Mr. W. H. WINTERBOTHAM, solicitor to the National Telephone Company, gave a history of the action which had been taken by the company in the endeavour to protect their interests. No one had needed to ask for protection except the company. He had taken part in opposing some 52 cases of tramways. Most of them had obtained their powers subject to the telephone company's protective clause. There were more working under the clause than otherwise, and in his opinion the action taken by the company had not prevented the extension of electrical traction.

LEAKAGE AND GAS PIPES.

Dr. JOHN HOPKINSON, recalled, said, in answer to the CHAIRMAN, that it was notorious that electrolytic action took place upon gas and water pipes. Such action had been found to become so serious that gas pipes in the United States had been actually eaten through in the very short time during which electrical tramways had been at work on a large scale.

PRACTICAL EVIDENCE.

The CHAIRMAN said that the committee thought it desirable to see the telephones at work, and it was arranged that they should visit the exchange at Leadenhall Avenue, Lime Street, on the following morning.

TELEPHONE COMPANY'S CHAIRMAN.

Mr. J. STAATS FORBES, chairman of the National Telephone Company, examined by Mr. PEMBER, said with regard to the alleged advantages of the metallic circuit in working the telephones, that, as a general proposition, he did not agree with the opinion that had been expressed as to its necessity. In certain towns the company had worked for some time in competition, so to speak, with the telephone lines of the G.P.O. It was said by some that it was impossible to conduct the telephone service efficiently without a metallic circuit. The company were doing 95 per cent. of their business upon an earth current, and out of London they were doing it efficiently, and their subscribers were fairly satisfied. As a matter of fact, from year to year, the cause of complaints which had arisen were being gradually removed. He had tried to find some method of testing the evidence in favour of a metallic circuit, and of measuring how far the public appreciated the company's system when it was brought into contest with the metallic system. The Post Office were competing with the company in certain places on a metallic circuit where the company used the single wire system, and he found the company had progressed, whilst the Post Office remained stationary or retrograded. In illustration of this, he instanced Sunderland, Derby, Leicester, Nottingham, Middlesborough and Hartlepool, in all of which towns the company's business had largely increased, whilst the P.O. business had greatly decreased. That was his answer to the suggestion that the company could not conduct their business with sufficient efficiency to meet the public requirements unless they adopted a metallic circuit. If that were so, why should the company be driven into this great expense? It was not to ensure the efficiency of the service, but upon a theory that they were bound to adopt it, and therefore, to have an obligation imposed upon them because other companies discharged into the earth volumes of electricity, which would destroy the possibility of continuing with the earth system. After all, the public would have to pay, and he had made a calculation that if the company were to apply the metallic circuit to their present system, the expenditure would be so great, as to render it impracticable. People lost sight of the fact that the company were in possession of a license for only 18½ years. They had spent £5,000,000 of money, and had to get that back in 18½ years. They would not feel inclined to spend another million or a million and a-half for a fancy purpose. He could not find any other reason for the remarkable development of the company's operations than that the earth system was the most effective, and it was certainly the most economical. And whether the money was the money of the State, or private money, what was the use of spending it if it was not necessary? He produced the balance-sheet of the company to April 30th, 1892, explaining that the balance-sheet for the present year was not quite ready. It showed that the company had spent a very large sum of money upon their enterprise as it stands. The capital was £2,540,000, and the debenture stock £726,000, a total of £3,267,000. They had now got to £4,276,000, the balance having been spent during the past year. They paid in post office royalties £40,239, nearly 10 per cent. of the whole receipts, the difference arising from the fact that the private wire income and income from some other sources did not pay royalty. They paid a dividend of 6 per cent. on their capital, but he would like to call attention to the amount carried to the reserve fund. In 1890 and 1891 they reserved £40,000. In 1892 the company made enormous concessions to different parts of the country in the matter of rates. The company were face to face with the consideration where they would be at the end of 18½ years. They had endeavoured to ascertain what the view of the Post Office was as to the estimated value of the property at the expiration of that term. The Post Office, he believed, had enunciated in a public document, a Treasury minute, that they did not intend to grant new licenses, except with certain provisions, longer than the extent of the company's license; so it meant that at that time the Post Office would make a clean start. And Mr. Lamb had decided to estimate the value of the company's concern at the end of 18½ years at £1,000,000. If that was anywhere near the truth, where was the difference between that million and the £5,000,000 to be got? If the company got it anywhere, they must get it out of the business, and that was not encouraging enough to induce them to expend any more millions or hundreds of thousands. He was not sure the time would not arrive when it would militate against the extension of the telephone business at all, because as the years advanced it would not pay the company upon any conceivable terms to take new business. They had to exercise extreme caution in avoiding the incurring of useless expense. Therefore, if their common law right, according to the Kekewich judgment, would not get them an injunction, and if they were to be driven to spend this money which was not wanted, it seemed a hardship.

In answer to Mr. HUNTER on behalf of the Postmaster-General, the WITNESS said that the figures he had given as to the falling off in the Post Office business were not supplied by the G.P.O. He had obtained the statistics through the company's officers on information which he believed to be perfectly reliable.

Mr. HUNTER thought it was only his duty to say that the Post Office was not in a position to admit them. He asked several questions with the view of showing that any falling off of business was not to be attributed to the metallic system.

Mr. FORBES said he was working under a department of the State, a licensee of the G.P.O. to carry on business which would be more properly carried on by them. It was a delegated public duty. The Post Office had a right to call upon the company to do that duty properly, and in protecting the interest of the company he felt that he was protecting the interest of the Post Office. At Sunderland the company were charging £10 for the use of the telephone over half a mile, and the Post Office were charging £8; but the company's business had increased, while that of the Post Office had diminished. Even at a reduced price the metallic circuit could not make headway against the company. At Newcastle the rate was £10, until the Post Office, without consultation, reduced theirs to £8.

Cross-examined by Mr. BROWNE: He thought the Post Office pushed their business with great vigour. Local conditions in London made a double circuit necessary. The reason why London had been so badly served was, that although the company had come time after time to Parliament for powers, they had failed to get them, they were obliged in London to find their way about as best they could, which resulted in some places in an extremely complex system, and sometimes, instead of a straight call they had to pass three exchanges. The multiplication of exchanges meant the multiplication of the chances of error. He had not said it might not be judicious to introduce the metallic system in certain places.

By Lord CLIFFORD: The necessity of several exchanges arose from the fact that the company could not get under the streets. They were at the mercy of owners of property. In some places they could not throw their wires anywhere over an entire estate, but had to go round it, and it was the necessity for the multiplicity of exchanges which made it difficult to carry on the earth system in London, or in any other city with overhead wires. There could not be underground wires except between certain fixed points. If in London, the company had power to use the streets as the Post Office used them, it would have greatly helped the service, because it would have diminished, the number of exchanges, and put many thousands in direct communication with each other, who now had to wait their chance at intermediate stations of transfer.

By Mr. BRUNNER: The company had bought up all the other companies—about 13, but upon the very rational ground that if telephony was to be effected with economy and efficiency, there must be some uniform plan of charge and control. No doubt the company's capital in the books meant a great deal more than had been spent on the structure as it stands.

EVIDENCE FOR THE RAILWAY COMPANIES.

Mr. ASPINALL, M.I.M.E., chief mechanical engineer to the Lancashire and Yorkshire Railway, examined by Mr. MOON, described the several lines of wire used in the working of the railway for block signals and other purposes. In all these they used the earth as a return. In 1891 they found that their lines were being disturbed. The instruments were thrown over to indicate the line was clear when it was actually not clear. There had been disturbances before, but they had been unable to satisfy themselves that they were due to the electric tramway. The disturbances had continued, and it had been found that whilst the disturbance went on throughout the day, it absolutely ceased at night when the tramway was not at work. It was absolutely essential that they should obtain protective clauses equivalent to those given them by the Bolton Tramways. These were to the effect that the corporation should construct their tramways so as to prevent leakage, and the corporation had also to give notice to the railway company as to how the tramways were to be constructed. The railway company were to protect themselves by wires, &c., the cost of which was to be defrayed by the corporation, subject to the decision of an arbitrator of the Board of Trade as to whether the work was necessary. If the decision was otherwise, the company would have to bear the expense. The cost of duplicating the system on the Lancashire and Yorkshire Railway would be about £48,000, which would include everything except the cost of maintenance, which would be about £7,700 a year, a very serious matter.

By Mr. BROWNE: The railway line would be affected wherever electric tramways were started in its vicinity, and there were a very large number of towns along the line that might use electric power.

He did not agree that the expenditure of the £48,000 would give the railway company absolute protection. They wanted in addition that the tramways should be compelled to have a metallic return. Whilst to-day the tramways were using currents of a comparatively small potential, no one could say what they were going to do in the future.

By Mr. HAMILTON: Telegraph currents would not interfere to any appreciable degree with the telephones. They would not prevent one from hearing the human voice.

Re-examined by Mr. MOON: The leakage from the tramways on to the railway system was a most serious matter. He would not be satisfied with the tramways defraying the cost of duplicating the company's wires. That would not furnish sufficient protection, unless the companies were compelled to use metallic circuits.

L. AND N.W.R. ENGINEER.

Mr. FLETCHER, principal assistant to the electrical enginer, London and North Western Railway, examined by Mr. MOULTON, gave evidence with regard to his experience at Walsall in connection with the influence of the South Staffordshire Tramways upon the working of the company's wires. The tramway was worked by an overhead conductor, the current being returned by the metals, and one of the poles was connected directly with the water mains. He should say it would not be a safe thing to allow that arrangement to continue. At the trial trip in November, the block instruments on the railway were deflected. On December 18th, all the bells rang on the section, and the instruments were deflected, false indications being given. The company had to abandon the use of earth as a return, and had had to make a metallic return. One return wire had proved sufficient for the seven outgoing wires in the yard at Walsall. If the company were to detect leaks readily they must put in some special appliances, and if they did not readily detect these currents when they were wandering about, there would be danger.

Cross-examined by Mr. BROWNE: The company had got rid of the disturbance by means of the return wire. The work cost £51.

By Mr. HAMILTON: One metallic return had been found sufficient for the 40 instruments in this case.

Re-examined by Mr. MOULTON: Currents passing along water pipes would tend to find out corroded points, according to their electric conductivity, and would ultimately destroy the pipes at these points. This would apply equally to gas pipes.

NOTES.

A Large Corona.—The dome of the main lobby in the new building of the German Imperial Diet is being equipped with what is claimed to be the largest corona existing. The diameter of the corona is 26 feet, and it is being fitted with 12 arc lamps and 250 glow lamps.

The Electrical Furnace and the Diamond.—The attempts at the reproduction of the diamond have recently met with great success, and have greatly interested the scientific world. Having regard to this fact, the Société Française de Physique, and the Société Internationale des Electriciens organised a special sitting, which was held on May 19th at the Conservatoire National des Arts et Métiers, and at which M. Moissan reproduced his principal experiments. M. Violle first described the electrical furnace, and gave a few explanations as to the light and heat of the arc. M. H. Moissan then described the analytical researches which preceded the study of the reproduction of the diamond. After numerous experiments, M. Moissan thought of employing pressure. He melted a mass of iron in the electrical furnace, fed by 75 volts and 400 ampères, by adding carbon in excess. The iron is thus saturated with carbon; when thoroughly melted, it is poured into a crystalliser filled with water. It is thus formed into a block with resisting sides, but with a liquid interior. All these experiments were reproduced before the assembly with complete success. It was this block which, on being tested with acids, furnished diamonds consisting of little black transparent particles, amongst others of other varieties of carbon. M. Moissan also made several similar experiments on the oxides of uranium, chromium, and manganese. He was thus able to prepare a certain number of refractory metals. We would call particular attention to the last experiment performed in public by M. Moissan, showing that silicium is volatile. A piece of rock crystal is placed in the electric arc, and the results are shown on a screen. The rock crystal was seen to decrease gradually in size, and the vapour was condensed into a bell-glass near. These various experiments, which were performed before a number of electricians and scientists, were carried out with great success.

The Lamp Situation in America.—According to the *Western Electrician*, the latest development in the incandescent lamp controversy is the arrangement between the Sunbeam company and the General Electric company amicably settling the litigation between these concerns. By the terms of this agreement, it is understood that the Sunbeam company and its customers are released from all claims for past damages and are relieved from an accounting. It is also claimed that the Sunbeam company will be permitted under the provisions of the agreement to dispose of the stock on hand, including lamps and material, thus practically closing up the business of that concern, as the arrangement does not provide for a continuance of the manufacture and sale of lamps. The agreement between the Sunbeam and General Electric companies does not in any way affect the Star Electric Lamp company, it is said, and the latter company will continue the manufacture and sale of the "New Sunbeam" lamp. Possibly this arrangement marks the beginning of a new policy on the part of the General Electric Company toward the other lamp manufacturers.

Rapid Transit Doctrine.—The *Street Railway Gazette*, in a recent issue, states that a London contemporary "facetiously recommends the importation of the Philadelphia clergyman who advocated the doctrine that the 'people have a moral right to rapid transit.' "We are inclined to believe," remarks our trans-Atlantic exchange "that some such a missionary is needed on the other side. When the London authorities defeat a railway project such as the Clapham Junction Road, because the operation of the proposed line might interfere with the delicate electrical experiments of a trio of learned scientists, the inference would seem to be that the English public stands sadly in need of the exposition of sound rapid transit doctrine. In this part of the world we are all converted to a belief in the value of fast local transportation, and when the people demand a railway that will accommodate some scores of million people in the course of a year, they get it."

Alternate Current Motors.—The manufacture of alternating and continuous current dynamos and motors, transformers, &c., is carried on at the works of Messrs. Brown, Boveri & Co., of Baden, near Zurich. In the workshops, alternating motors are used, running noiselessly and without sparking, and direct current motors can be operated at the side of them. Power is obtained from a waterfall nearly two miles distant, and the plant which comprises three turbines and three alternators of 200 H.P., is also used to supply between 2,000 and 3,000 incandescent lamps to the town of Baden. The electrical equipment of the Heilmann locomotive is being built at the company's works. At the Oerlikon Engineering works, alternate motors energised by triphase currents are used to operate a large overhead travelling crane. Three motors are in use; one controls the lifting and lowering; the second, the lateral movement of the windlass; and the third, the longitudinal travel of the bridge or carriage. Cranes on this system are made to deal with loads of from 5 to 40 tons.

Humbugging the Medical Council.—"My attention," says *Truth*, "has been called to a startling method, which has been successfully practised, of humbugging the custodians of the Medical Register. A qualified practitioner on the register dies somewhere outside the purview of registrars of deaths. Let us call him Mr. John Brown. Mr. Tom Jones, possessing no other qualifications for practising medicine, purchases Brown's diploma from his widow or other representatives. He then goes to Somerset House in the character of John Brown, and obtains the usual documents changing his name to Tom Jones. With these he proceeds to the office of the Medical Council, still in the character of the deceased Brown, presents his documents from Somerset House, and his diploma, if it is wanted, and gets the name of John Brown on the register altered to Tom Jones. Tom Jones is then in the eye of the law a fully-qualified medical practitioner. I understand that there is a market always open for the diplomas of deceased medicos, and there is no doubt that they have been utilised in this way—how often can only be conjectured. The General Medical Council would do well to give its attention to this fraud—not to mention others."

Union of German Electrical Engineers.—This society will hold its first ordinary meeting in Cologne on the 28th, 29th, and 30th September. The subjects to be considered will include the reading of papers, the determination of the rules of the Union, the question of participating in the Industrial Exhibition to be held in Berlin in 1896, and the the regulation of Sunday rest in electrical works.

Launceston Electric Lighting.—Several adverse opinions have been expressed in connection with the tunneling for the electric light scheme at Launceston, says the *Building and Engineering Journal*, and in order to test the matter the Council have decided to call for tenders for the work. The tunnel is to be 2,800 feet long, with concrete lining where necessary.

Junior Engineering Society.—The first summer excursion of this society took place on Saturday, June 10th, when, through the kindness of Messrs. P. K. Stothert and H. G. Massingham (the respective managing directors), a fair number of the members journeyed to Bath for the double purpose of paying a visit, in the morning to the engineering works of Messrs. Stothert and Pitt, Limited, and in the evening to the City of Bath electric lighting and engineering works.

Central London Railway.—The Central London Railway Company's plans in regard to the proposed central station at the Mansion House have been approved by the City Commissioners of Sewers. The plans show seven staircases, connecting with the subways and the railway station. The principal access to the subways will be by two staircases on the western front of the Royal Exchange—one at Threadneedle Street, and the other at Cornhill—and a third at the junction of Queen Victoria Street and the Poultry. There will be two staircases at the corner of Princes Street, one in Mansion House Place, and one in Walbrook. The staircase abutting against the Bank had been abandoned. Considerable areas would be taken out of the public ways for the staircases. These, however, would provide subways for pedestrians, and openings to the railway station.

Where the Telegraph is least Used.—The four countries in the world which possess the smallest telegraph facilities are Peru, Paraguay, Uruguay, and Persia. In the first-named there are only 36 telegraph offices in the whole country, and but 1,600 miles of wire. In the territory of Paraguay there are only 510 miles of wire in operation, and the entire telegraphic service of that country requires the services of but 28 persons. One line of 360 miles, owned and operated by the Government, runs from Asuncion to Paso de Patria, the limit of Paraguayan territory, and the other 150 miles by the railroad from Asuncion to Pirapo. Owing to high water and camp fires in that country, the line is often interrupted for days at a time. At Paso de Patria the line breaks, there being no cable over the Alto Parana River, which is three miles wide. Communication is therefore by canoe, which takes messages over in the morning to the Argentine side and returns to the Paraguayian side at night. An important telegram is often delayed 10 or 15 hours.

Birmingham Electric Lighting.—It is anticipated that new notices will be given this month by the Birmingham Electrical Supply Company of their intention to apply for a provisional order extending their area of supply. In view of this, the subject of electric lighting has been occupying the attention of the Electric Lighting Sub-Committee, to whom it was remitted by the General Purposes Committee of the City Council. Reports have been obtained from the various electric lighting companies, and from corporations which have undertaken the supply, and very full information has been collected for the guidance of the Council. Some members of the committee are understood to be anxious that the Corporation should undertake the supply, but others consider that the time is scarcely ripe for an enterprise of such magnitude. Meanwhile negotiations are in progress with the directors of the Electric Supply Company, and the ultimate decision will largely depend upon whether they see their way to adopt certain conditions upon which the Corporation might consent to the extension of their district.

Bills in Parliament.—In the House of Lords, last Friday, the City and South London Railway Bill, the City of London Electric Lighting Bill, and the Waterloo and City Railway Bill, were read a second time.

Electric Tramway in Paris.—Since November, 1892, Paris has possessed an electric tramway with Laurent-Cély accumulators. The tramway company has just started another between the Opéra and Saint Denis. This second line is exactly similar to the first. The charging station is established at the tramway depôt at Saint Denis. Thus Paris possesses only two electrical tramways, and we may say that electric traction is in a very backward condition.

The French Thomson-Houston Company.—A French company has just been formed for working, in France, some of the Thomson-Houston patents relating to the transmission of energy, electrical traction, and electric lighting. This new company is established at No. 27, Rue de Londrès. The council of administration consists of Messrs. Thurnauer, Mercet, Foiret, Chamon, Burrell, Abdank-Abakanowicz, Crosby, Davenport, Frager, Postel-Vinay, Renard and Siry. The board of directors consist of Messrs. Chamon, Frager, Renard and Thurnauer. The agent is M. Canderay.

Libel Action against "Electricity" (N.Y.).—We have recently commented rather extensively upon the position of affairs in America, especially in regard to the monopolist company, the General Electric. Our New York contemporary, *Electricity*, has from time to time been very bold in the assertions and opinions to which it has given publication regarding trusts and monopolist amalgamations, and has contrived to speak with no uncertain sound, with the result that the General Electric Company have entered proceedings against the publisher of the journal, charging him with criminal libel.

Coast Communication.—The Chancellor of the Exchequer, replying to Mr. Munro Ferguson in the House of Commons last Friday, said a cable was almost immediately to be laid to Lundy Island. Electric communication had been authorised to 16 shore lighthouses, and in some cases had been completed. Lightships and rock lighthouses would be taken in hand as soon as means were available.

Mr. G. Roper, of the Board of Trade, having been appointed private secretary to Mr. Mundella, has relinquished the position of secretary to the Royal Commission upon Electrical Communication between Lightships and the Shore, and Mr. E. G. Moggridge, of the Board of Trade, has been appointed to succeed him in that position.

International Progress Exhibition at Paris in 1893.—As we notified in our issue of June 9th, an International Progress Exhibition will be opened at Paris in October, 1893, at the Palais de l'Industrie. Electricity will be largely represented; two special classes will be devoted to electrical exhibits. They will be sub-divided as follows: Class 20.—*Electricity.*—Machines for producing electricity; Various apparatus for lighting the coast by electricity; Lighthouses, &c.; Public electric lighting; The lighting of monuments; The lighting of dwelling houses; Electric motors; Electric batteries: Electric meters; Accumulators; Carbons; Various electrical accessories and applications; Experiments. Class 21.—*Telegraphy and Telephony.*—Apparatus required for electric telegraphy; Telegraph wires; Electric bells and signals; Compasses; Apparatus for transmission and distribution for long and short distances; Telephones; Telephone apparatus and plant; Various accessories for telegraphy and telephony; Illustrations of telephony. This exhibition will be interesting as a distribution of electrical energy will be established, and the various apparatus will be seen at work. The distribution will be effected with alternating currents at 110 volts and 40 periods per second from the sector of the Champs-Elysées. Comparative experiments will be made with all the apparatus. It will be an opportunity for the manufacturers of alternate current motors to submit them to a competent jury. The executive committee includes MM. Fontaine, Mounier, Hospitalier, Meyer, Postel-Vinay, and Sciama. The offices for the administration of the exhibition are at 3, Rue des Pyramides, Paris.

Hobart Electric Tramways.—The Electric Tram Station, Hobart, is now almost finished, and will shortly commence working. The plant is said to be an exceptionally fine one.

The Société Française d'Accumulateurs Electrique.—A recent action for infringement by this Society, against M. Rousseau, has been decided against the defendant. The judgment, which is a long and elaborate one, was given on the 5th of last month.

The Electric Lighting of Toulouse.—The last issue of *Le Genie Civil* contains a very detailed description of the electric lighting works at Toulouse. Illustrations are very numerous, showing a variety of views at the station or in connection with the work. The following are a few of them :—Exterior of station, interior of machinery hall, interior of boiler room, general plan of the town of Toulouse showing the district lighted, view of the Toulouse Boulevards with arc lamps erected. An outline plan and elevation of the works is presented as a supplemental sheet. There are also some interesting diagrams showing the enhanced production, and the improvement in the receipts, during the three years from January, 1889, to December, 1892. The works are established for lighting 12,000 10-C.P. lamps.

The Telephone in Sweden.—A report to the Foreign Office from Consul Constable, of Stockholm, deals with the growth and recent rapid extension of the telephone system in that country. In the year 1891 the State Departments of Telegraphs and Telephones were partially amalgamated, and undertook the inter-urban extension of the latter, which had become inevitable. As a result of this arrangement and of the negotiations leading up to it, a keen competition between the State Telephone Department and the Stockholm Allmanna Company has ensued. Beyond the limits of Stockholm the Government Department has altogether the advantage, and is rapidly acquiring property in such outlying lines of the Allmanna as are already in existence. Within Stockholm itself the issue is not so clear, for the Allmanna is a rich and powerful company, established since 1883, which musters at the present moment some 7,000 subscribers, whereas the State Department has only some 1,600 subscribers. At the present moment the Allmanna Company is being compelled to adopt the metallic circuit system in Stockholm. Mr. Hultman, Chief Inspector of the State Telephones in Stockholm, states that the work of extending the network of telephones between all the towns of any importance in the kingdom would, it was confidently anticipated, be completed within the next 4 or 5 years. By that time it would be possible to converse between Haparanda, at the extreme north, and Malmo, at the southern point of the peninsula. It is not expected that the great distance (933 miles) will prevent good speaking. In Stockholm the Government has laid down underground cables, which have cost no more than overhead cables, that is to say, 10 öre (1½d.) per metre per subscriber, which is only about double the price of a single aerial line. Mr. Hultman states that the underground cable systems which he inspected in America has cost at least four or five times as much. The report concludes :—I inquired of Mr. Hultman whether he could tell me, apart from the question of economy, wherein the acknowledged superiority of the Stockholm Telephone system (Almanna as well as Government) consisted. He replied that it mainly consisted in the excellence of the instruments and materials employed, and the high standard of workmanship exacted in every branch of construction. Mr. Hultman was very emphatic about the mistake that had often been made in other countries, and to a certain extent also in Sweden, in laying down, for the sake of cheapness, single grounded lines instead of double metallic circuit lines. Another point of superiority, in Mr. Hultman's opinion, is the great care that is taken in Stockholm with regard to the efficiency of the staff of employés. For instance, he informed me that an inspector every day goes round among the subscribers' instruments. He is provided with a stop-watch, and when he makes a call he notes the number of seconds that lapse before he receives an answer from the exchange station. Thus each employé at the exchange finds himself (or herself) confronted every morning with a slip of paper on which is written his record of the day before.

Chelsea Electric Lighting.—The Board of Trade have revoked the St. Luke, Chelsea, Electric Lighting Order, 1891, as confirmed by the Electric Lighting Orders Confirmation (No. 10) Act, 1891.

Statue of Arago.—On the 11th inst., the inauguration of a statue of Arago took place in the Paris Observatory, being the centenary of the birth of that philosopher. As the discoverer of the electro-magnet, and of the Arago "disc," his name will be, probably, best called to mind, though as an energetic worker in a very wide field of science his life will probably be long remembered.

Brighton Electric Lighting.—At a meeting of the Brighton Town Council, last week, complaint was made of the manner in which the streets were being broken up for the purposes of the electric light. It was pointed out, however, that such a large undertaking could not be carried out without some inconvenience, and the manager had given an assurance that the work would only take another fortnight.

Electric Plant on Fire.—A telegram from Elizabeth, N.J., dated June 20th, states that the plant of the electric light company was discovered to be on fire at midnight on 19th inst., when every electric light in the city became extinguished, leaving it in total darkness. The building continued to burn, and it is feared that in the hurry and confusion some workmen perished. Many others ran for their lives, leaving all their clothes and personal effects behind them.

Brighton-Rottingdean Electric Railway.—The Unopposed Bill Committee of the House of Lords, on Tuesday, sanctioned the Bill incorporating a company to construct an electric railway along the foreshore from Brighton to Rottingdean. A landing stage at Rottingdean, which the Bill empowers the company to construct, will extend for a distance of 200 feet into the sea. The Bill provides that the carriages and platforms are to "be placed at such an elevation as to be safe from interruption by the sea."

Three Oft-repeated Names.—This is what *Money and Trade* says :—"If ever restitution were clamoured for from the vendors of any business, it might be done in the quarter of the various Elmore Copper Companies. The parent copper-depositing concern has always been upon the eve of revolutionising the trade in copper cylinders, steam pipes, and boiler tubes ; while the result, as seen by the course of the shares, lies in the fact that the £2 share, which stood at £8, has steadily improved to exactly the number of shillings, the official selling price being ⅜. The Elmores, the Woodhouses, and the Rawsons have always figured as benefactors of the human race, and have sown their businesses broadcast for a trifling purchasing price, of which they have taken as much in cash as they could. Instead of these heavily capitalised companies ever attaining a sound dividend-paying position, they have slipped down and down in value until the shareholders begin to wonder where the decline will end."

The New Central Laboratory of the Société des Electriciens.—The question of the central laboratory has often been discussed by the Société des Electriciens. It will be remembered that this laboratory was constructed with the material remaining over from the Exhibition of 1881, which stock was only able to be disposed of a few years ago. The necessary preliminaries for selecting and obtaining a plot of land for the building of the laboratory occupied a considerable time. Thus, in about 1888, the laboratory was established temporarily at Grenelle, on some ground which Messrs. Menier placed at the disposal of the Society. Negociations were continued, the City of Paris granted a plot of land, and the laboratory is now finished. The inauguration took place June 14th, under the auspices of M. Terrier, Minister of Commerce and Industry. The installation is not quite completed, but will be shortly. On our visit we found a large engine-room, with transmission axles and rails, one gas motor of 10 H.P., one locomotive. The various measuring apparatus are distributed through several rooms situated on the ground floor of the main building.

Personal.—Mr. Rankin Kennedy left London on Friday last, and Prof. Ayrton on Wednesday, for Chicago.

Richmond Electric Lighting.—Mr. Shoolbred has resigned the post of electrical adviser to the Town Council.

Harrogate Electric Lighting.—We hear that the projected floating of a private company for the supply of electric light for Harrogate has been abandoned.

Dieppe Electric Lighting.—A company has just been formed with a capital of 120,000 francs, to be known as the Société d'Eclairage Electrique de Dieppe.

Electric Lighting at Guildhall.—The City Lands Committee intend asking leave to extend the electric lighting of Guildhall to the museum, at an estimated cost of £360.

Correspondence.—Owing to pressure of matter, and correspondence arriving too late for insertion, we regret that we are reluctantly compelled to hold over several letters of importance.

Not American.—We should like to correct a little hint which the New York *Electrical World* makes with reference to the recent articles in our columns by Mr. Dallas, on traction motors. The *Electrical World* styles them as "presumably of American origin." Mr. Dallas is of the "London Scottish." *Verbum sap.*

Private Bills in Parliament.—On 19th inst., the Committee on Unopposed Bills in the House of Lords passed the City of London Electric Lighting Bill, which authorises the amalgamations of the various undertakings having charge of the electric lighting of the City. A Bill entrusting the electric lighting of Islington to the vestry, passed the Standing Orders of the House of Commons.

Telephone Dangers.—A fatal accident illustrating the dangers of the telephone in storms has just occurred at Metz during the progress of shooting practice by the 34th Regiment of Field Artillery. An artilleryman approached the telephone receiver when the conductor wire was struck by lightning, the soldier being killed, and another having his feet paralysed.

Electric Lighting at Lyons.—An electric lighting installation has been erected in the neighbourhood of Bellecour by Messrs. R. Alioth & Co., of Bâle, and consists of two multitubular boilers, a dynamo machine for 250 ampères and 170 volts, and a battery of accumulators giving, with 70 cells, a discharging current of 120 ampères. The *Bulletin International de L'Eléctricité* states that the local gas company is becoming concerned regarding the competition.

The Leakage Current from Electric Tramways.—It is generally admitted that the electric tramway companies never intentionally use the earth as a return. One of the tramlines is generally used, the rails being bonded together with a copper strip or wire in order to make a continuous length. The question which arises in our mind is whether some improvement might not result by transversely connecting the two rails at intervals with a copper wire. It seems reasonable to assume that there might be some advantage in doing this. Perhaps some of our readers may have had experience in this direction; if so, we should be glad to have their views. On referring to a back number of an American magazine, we find that this plan has been adopted on an American line.

Effect of Dynamos on Ships' Compasses. — The Admiralty has directed, says the *Daily News*, that all ships fitted with 300 and 400 ampère dynamos are to be specially swung for the purpose of ascertaining the effect of the dynamos on the ships' compasses. The effect on all the compasses is to be specially noted, and a report forwarded to the Admiralty. The Lords of the Admiralty have directed that the minimum distance between dynamos and compasses is to be 60 feet in the case of a 300, and 70 feet in the case of a 400-ampère machine, and in the light of the experiments that are now to take place it would be interesting to know the distances between the dynamos and compasses of three of Her Majesty's ships that have recently been damaged by getting into positions at direct variance with the navigator's intentions.

NEW COMPANIES REGISTERED.

Pioneer Electric Carriage Company, Limited (39,009).—This company was registered on the 8th inst., with a capital of £20,000, in £50 shares, to develop traction and propulsion of vehicles or carriages on tramways, highways and roads, by means of electricity; to construct electrically-propelled or other vehicles, and to enter into an agreement with the Electrical Power Storage Company. The subscribers (with 1 share each) are: J. I. Courtenay, 1, Essex Court, E.C., Barrister-at-Law; F. King, Brightlands, Barnes, Surrey, engineer; J. W. Barclay, 5, Clarendon Place, Hyde Park Gardens, W.; G. R. Prescott, Bart., 9, Clarges Street, W.; C. E. Webber, 17, Egerton Gardens, S.W., retired Major-General; S. Cooper, Bart., 6, De Vere Gardens, Kensington, W.; F. Green, 13, Fenchurch Avenue, E.C., shipbroker. The number of directors is not to be less than two, nor more than seven. Qualification, £100. Remuneration to be fixed in general meeting. Registered by Renshaw, Kekewich & Co., 2, Suffolk Lane, E.C.

Richard Poore & Co., Limited (39,024).—This company was registered on the 10th inst. with a capital of £6,000 in £1 shares, to adopt an agreement made between Richard Poore and Walter Wheeler, to acquire the patent referred to in this agreement, and to obtain any inventions capable of being used to advantage, to construct any buildings or works necessary or convenient for the objects of the company, and to carry on the business of electricians, suppliers of electricity for the purposes of light, heat, or motive power, and general engineers. The subscribers (with one share each) are:—Wm. S. Francis, 58, De Beavoir Crescent, N., clerk; C. J. Odhams, Anerley, S.E., clerk; N. W. Richards, Upton Park, E., clerk; W. E. Kenderdine, Hackney, N.E., clerk; A. Blythe, 30, Daleview Road, N., gentleman; C. O. Decker, 25, Halley Road, Forest Gate, clerk; C. Ament, 10, Albion Grove, N., clerk; Messrs. A. Blythe and G. V. Currie are the first directors of the company. Qualification, 100 shares. Registered by T. D. Pettiver, 21, College Hill, E.C.

Merionethshire Electric Lighting and Power Appliance Company, Limited (39,011).—This company was registered on the 9th inst. with a capital of £3,000 in £1 shares, to establish and carry on at Dolgelly, and elsewhere in Merionethshire, the business of an electric lighting and electric power supply company, together with the trade of electricians and mechanical engineers. The subscribers (with one share each) are: H. May, 24, North John Street, Liverpool, architect; W. Williams, Angel Hotel, Dolgelly, hotel proprietor; J. C. Roberts, Dolgelly, wine merchant; F. Whiteley, Helsby, managing director; H. W. Bretherton, Chester, accountant; A. Thorburn, Rainhill, Liverpool, corn broker; F. H. Handy, 33, North John Street, Liverpool, accountant. Six of the above gentlemen are to be the first directors of the company; qualification, 10 shares. The regulations of Table A apply in most cases. Registered by Jordan and Sons, 120, Chancery Lane, W.C.

Ford-Lloyd Manufacturing Company, Limited (38,998).—This company was registered on the 7th inst. with a capital of £10,000 in £1 shares, to purchase the business of electrical engineers, and manufacturers of electrical appliances, heretofore carried on by the Ford-Lloyd Manufacturing Company, at No. 8, Mount Pleasant, Clerkenwell, E.C., and the sole right to sell and dispose of the invention known as the "E. S. Dry Battery," and the assets and liabilities of that firm in connection with the above-mentioned business, and also the premises known as the Penarth Works, Bermondsey, S.E.; to enter into an agreement for that purpose; and to carry on the business of electrical engineers and all analogous trades. The subscribers (with one share each) are:—Arthur Ford-Lloyd, 5, Hunter Street, W., engineer; E. J. Tumber, 12, St. George's Row, S.W., engineer; C. H. Elliot, 27, Croydon Road, Beckenham, electrical engineer; E. P. Grove, 5, South Parade, S.W., engineer; A. Grundy, 32, Brassey Square, S.W., electrician; W. M. Foxcroft, 36, Percival Street, E.C., telegraphic cabinet manufacturer; E. A. Herbert, 7, Humber Road, Westcombe Park, electrician. Many of the rules of Table A apply. The first directors are E. J. Tumber, A. Ford-Lloyd and C. H. Elliot. Qualification £500. Registered office, 2 and 4, Phœnix Place, Mount Pleasant, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

New Zealand Electrical Syndicate, Limited.—The annual return of this company made up to the 11th of last November, has lately been filed at Somerset House, and shows that out of a nominal capital of £30,000, in £10 shares, 2,955 have been taken up, of which 200 were issued as fully paid. The full amount has been called upon the remaining 955 shares, and the calls amount to £6,350. There is £3,200 in arrears.

Mexican Gas and Electric Lighting Company, Limited.—The annual return of this company shows that the whole nominal capital of £100,000, in £20 shares, has been issued as fully paid.

London Platino-Brazilian Telegraph Company, Limited.—The annual return of this company was filed a short time ago, and shows that 37,548 £10 shares have been taken up out of a total of 40,000. A sum of £375,480 has been paid, and 800 shares have been forfeited.

West India and Panama Telegraph Company, Limited.—The annual return of this company was filed at Somerset House on the 6th inst., and reveals the fact that out of a nominal capital of £2,445,630, in 200,000 ordinary, 34,563 first preference, and 10,000 second preference shares, all of £10 each, 88,321 ordinary, the whole of the first preference, and 4,669 of the second preference shares have been taken up. There has been £10 called up on each of these shares, and the total amount received in this respect is £1,275,530.

West Coast of America Telegraph Company, Limited.—The annual return of this company was filed on the 25th ult., and shows that out of a nominal capital of £300,000 in £10 shares, 30,000 shares have been taken up. The full amount has been called, and £300,000 is the result.

Willans and Robinson, Limited.—The annual return of this company shows that 2,214 fully paid £50 shares, together with 58 £5 and 11 £25 shares, have been taken up, out of a capital of £200,000. There has been £62,265 paid, and £49,000 has been considered as paid.

Westminster Electric Supply Corporation, Limited.—The annual return of this company, as filed at Somerset House, shows that out of a nominal capital of £300,000 in £5 shares, the whole of the shares have been taken up and paid.

CONTRACTS OPEN AND CLOSED.

CLOSED.

Ealing.—The following list of tenders for electric lighting machinery was read:—

Clark, Muirhead & Co.	£7,440 0
Crompton & Co., Limited	7,480 0
Willans & Robinson	8,511 0
Siemens Bros. & Co., Limited	8,754 0
Ronald A. Scott	9,000 0
Allen & Co.	9,300 0
Electric Construction Corporation	9,381 0
Ferranti, Limited	10,075 0
Johnson & Phillips	10,160 0
Paterson & Cooper	10,160 0
Woodhouse & Rawson	10,300 0
J. W. Goolden & Co.	10,881 0
Fowler & Co., Leeds	11,087 3
Mathew, Paul & Co.	12,000 0

The tender of Messrs. Clark, Muirhead & Co., has been accepted.

Woolwich.—The tender of Messrs. Reid Brothers has been accepted for the electric lighting works at Woolwich, which will be commenced on Monday, the 26th inst.

OPEN.

Burnley.—June 27th. For the fitting up 82 electric lamps, including wires, fittings, lamps, &c., upon their premises at Keighley Green, Burnley, for the Committee of the G.U.O.O.F. Central Club. Copies of specification and plan can be obtained on application to Mr. Tom Cross, secretary. Tenders to be sent to the Secretary by 27th inst.

Gartloch (Glasgow).—June 26th. The Glasgow District Lunacy Board invite tenders for an installation of the electric light into the asylum buildings at Gartloch. Intending contractors are requested to send names by 26th inst. to Mr. Dempster, Clerk to the Board, 318, Parliamentary Road.

Glasgow.—June 26th. For the supply and fitting up of three Lancashire steam boilers, to be used in connection with the electric light and for other purposes, at Gartloch Asylum, for the City of Glasgow District Lunacy Board. Intending contractors must send their names by 26th inst. to Mr. Dempster, Clerk to the Board, 318, Parliamentary Road.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

What Municipal Authorities are Doing.—BOLTON TOWN COUNCIL.—The Bolton Town Council have been considering electric lighting for some time past, yet they have only within the last few days earned the distinction of being placed under this heading. The minds of the Town Councillors have alternated a good deal between the high tension continuous current with motor generators, and high tension alternating. They must have been decidedly partial to the Oxford system, for it is stated that members of the committee visited the town of Oxford twice, the second time in company with their recently appointed engineer. However, they have now decided to adopt a high tension alternating system, with transformers placed in sub-stations. We suppose it must have been the intention of the Town Council to work a lighting and traction system together, for the committee state in a recently issued report, that "whatever system be adopted for lighting purposes, any proposed electric tramway service must be kept quite distinct from it." In this the Council have determined wisely, for we have pointed out quite recently the impossibility of such a combination.

From what we know of Bolton, the alternating current system is the most suitable one to adopt; for although the area to be immediately lighted is fairly compact, the extensions will be mainly in straggling districts—straggling in the sense of consumers. We think, however, that a little too much caution is being exercised in laying down the first instalment of plant, which is designed to deal with about 4,000 lamps. Of course, the Council, with their intimate knowledge of local conditions, are the better judges in this matter; but plant which could deal with 10,000 lamps could be laid down at comparatively low increased cost. The plant will consist of three Lancashire boilers, 30 feet by 7 feet 6 inches, for 120 lbs. pressure; two compound vertical engines of 160 B.H.P.; one compound vertical engine of 80 B.H.P.; two compound vertical engines of 15 B.H.P.; two 100-kilowatt alternators for 2,000 volts and 50 ampères; one 50-kilowatt alternator for 2,000 volts and 25 ampères; two exciting dynamos; pumps, steam pipes, switchboards, &c. In addition to the exciting dynamos, a small set of accumulators are to be fixed at the generating station. The estimated capital outlay for plant for 4,000 16-candle-power lamps, on the alternating current transformer system (four centres), as approved by the sub-committee, is as follows:—Boilers, pipes, &c., £3,600; engines, &c., £2,600; dynamos, &c., £2,750; switchboards, £950; transformers, &c., £1,120; accumulators, &c., £150; mains, &c., £4,000; buildings, £3,500; crane, £375; station lighting, £75; water tank, £75; meters, £500; contingencies, £1,500; total, £21,195. The estimated running expenses for plant for 4,000 16-candle-power lamps, for an output of 180,000 units per annum, is estimated altogether at £4,057 10s., or a cost of 5·4d. per unit. It is to be sincerely hoped that the Council will do better than this, for if a little over 5d. a unit is what they are to strive for, they are not going to accomplish much.

SUNDERLAND AUTHORITIES.

The Sunderland Town Council has adopted a report of Prof. Kennedy's, which estimates the cost of a central station capable of commencing a suitable supply of electricity at £17,000. The report is based on the annual consumption of 100,000 units. What may be considered as a curious suggestion, coming from a Town Councillor, was that of Alderman Robson, who took exception to Prof. Kennedy's advice as to the adoption of steam engines. The worthy Alderman suggested that Prof. Kennedy had not taken into consideration the kind of water they had in Sunderland and the state of the boilers. Although it might cost more, he hoped that gas engines would be adopted. Now, this is an extremely sensible suggestion on the part of Mr. Robson, and although we do not think, at present, that Prof. Kennedy is likely to depend entirely on gas engines, still we are glad to see that Town Councillors are becoming alive to the future developments of the central station.

The Liverpool and District Pulsion Telephone Company, Limited.—The creditors of the above-named company are required, on or before the 1st day of August, 1893, to send their names and addresses, and the particulars of their debts or claims, to John Merrett Wade, of 5, Fenwick Street, Liverpool, Chartered Accountant, the liquidator of the said company, or in default thereof they will be excluded from the benefit of any distribution made before such debts are proved.

Bedford Electric Lighting.—At the last meeting of the Urban Sanitary Authority, the Electric Light sub-committee reported that in response to their advertisement inviting tenders or applications from companies or firms willing to undertake and carry out the powers granted under the provisional order, they had received three replies.

No. 1, was from Mr. F. H. Medhurst, of Cambridge, and contained two alternative propositions (*a*) a proposition to transfer to himself, under certain conditions, the provisional order; (*b*) a proposition to erect for the sum of £24,000 a complete installation.

No. 2, was an approximate estimate from Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne (the firm that erected the Cambridge installation) for laying down a plant here at a cost of £12,000, exclusive of buildings.

No. 3, set forth memoranda of terms upon which the Bedford Electric Light Company, Limited, was willing to undertake and carry out the order.

The committee had carefully considered the foregoing applications, and were of opinion as to No. 1, that it would be injudicious to entrust a work of such importance to a private individual; as to No. 2, they considered that it did not comply with the terms of the advertisement. The only application that fully conformed to the terms of the advertisement was No. 3, that of the Bedford Electric Light Company, Limited, and was in their opinion the only one that they could recommend the Authority to entertain.

The whole question was referred without discussion to a special meeting.

Electric Cable Lost in Transit.—In the Queen's Bench Division on Tuesday and Wednesday, Mr. Justice Collins was engaged in trying an action brought by the Fowler-Waring Cable Company, Limited, against the General Steam Navigation Company, to recover damages for the loss of a drum of electric cable. The point upon which very long arguments were addressed to the Court was whether the shipowners were entitled, after giving a bill of lading, to deliver up the electric cable to a person who did not produce the bill of lading. The case for the plaintiffs was that the drum was entrusted to the defendants for conveyance from London to Amsterdam, to be delivered to one Hekker, and the defendants delivered the cable to the wrong man. The plaintiffs had not been able to get the price of the cable, and claimed damages. The defence was that the contract to carry was made in a consignment note, which simply said "Please deliver to Hekker," and that while the cable was at sea the plaintiffs asked for and obtained a bill of lading. Mr. Justice Collins gave judgment for the plaintiffs, holding that the consignment note did not override the bill of lading. Judgment accordingly entered for the plaintiffs for the agreed value of the cable, £88 6s. 4d., and costs.

The London and Lancashire Electric and General Engineering Company, Limited.—This company, the management of which we noted a short time ago was taken over by Mr. C. N. Russell, A.M.I.C.E., are now, we understand, very busy in all departments, and have recently completed installations of electric light for the New York Mutual Life Insurance Company, Holborn, Messrs. Higgs & Co., Islington, Mr. J. T. Lipton, Croydon, and the Bolton Mansions Hotel, Earl's Court; while the contracts now in hand include a complete installation of electric light for the British Paper Company, Limited, who have placed the order for lighting their "Frogmore Mill," at Hemel Hempsted, with the company; both incandescent and arc lamps are to be used, the latter for colour testing, as the mills run night and day. Installations are also in hand for the Central Advance and Discount Bank, 84, Charing Cross Road; Messrs. Rising and Ravenscroft's offices, Leadenhall Street, E.C.; Messrs. Pryke and Palmer, Upper Thames Street; J. N. Pimm, Esq., C.C., The Manor House, Staines; Dr. Stott, Southgate; also the branches of Mr. J. T. Lipton, at Sheffield and Portsmouth. The company, who undertake general engineering work, are well employed in that department, and have recently put down new plant.

Battery Tests.—The following is an extract from the results of the examinations and tests made by Prof. H. F. Weber, of Zurich, of the accumulator batteries at Union Bank, St. Gallen:—"1. The electric current used for charging the batteries was 698·97 ampére-hours; on being discharged the batteries gave 674·84 ampère-hours; hence the effective current hours in relation to the total electric current hours is 96·5 per cent. 2. The electric energy required for charging was 94,770 watt-hours; on being discharged it delivered in the external circuit 78,080 watt-hours; the ratio of the effective energy to the total charging energy is therefore 82·4 per cent. As in accordance with my extensive experience, well constructed, carefully served, and continually active accumulator batteries yield on discharge from 93 to 95 and 97 per cent. of the electric current used for charging, and 80 to 82 and 84 per cent. of the electric force used in charging. I consider that the E.P.S. accumulator batteries supplied to the Union Bank by Messrs. Gmur Brothers are now in the best possible condition, and of very good working capabilities."

Fowler, Lancaster & Company, Limited.—The petition of the Electrical Company for an order to wind up Fowler, Lancaster & Company, Limited, came before Mr. Justice Vaughan Williams, sitting as an additional judge in the Chancery Division, on Wednesday. Counsel stated that the company had gone into voluntary liquidation, and the only thing was that the petitioners wanted some liquidator added who would represent the unsecured creditors. A gentleman had now been appointed, with whom the petitioners were satisfied, and were therefore willing that the petition should be dismissed without costs. His Lordship assented.

"Electric Light and Power."—The Electrical Installation Company, Limited, of Westminster, apparently considering that there existed the necessity for a "short treatise on the advantages and applications" of electric light and power for the private consumer, have just published a pamphlet on the subject with the above heading. Although the price, "one shilling," is stated on the cover, it certainly appears that the book is intended to be largely an advertisement of the business of the publishers. There are, however, some very interesting and useful remarks, and on the whole the pamphlet, which consists of 40 pages (one-third of these being advertisements), has been fancifully got up. The following are a few of the headings:—The only light which is healthy; The only light which is clean; The only light which is safe; How the light should be arranged, &c., &c. At the end are some abstracts from the "Glossary of Technical Terms," recently published in the pages of one of our contemporaries.

The Action against the City of London Electric Light Company.—The action by the Corporation of London, as Governors of Bethlehem Hospital, against the City of London Electric Light Company, Limited, to restrain them by injunction from excavating the ground under Lime Street Square, with the object of forming a reducing chamber there, has now been settled. When the motion for interim injunction was again mentioned before Mr. Justice Stirling, in the Chancery Division, on Friday last. Counsel intimated that terms had been arranged by which the defendant company undertook to lease from the plaintiffs the chamber excavated at £10 a year for 21 years, and to pay the plaintiffs' costs as between solicitor and client. On this undertaking all further proceedings in the action would be stayed.

Automatic Transformer Switch.—Messrs. New and Mayne write us as follows:—"Referring to your notice of our 'automatic transformer switch' in the current number of your paper, it would appear that the clockwork trains 'made' and 'broke' the primary switch; these trains are in reality delicate relays, which are automatically reset by the moving switch lever, and *do not require any attention whatever*, which release stored-up energy at the proper times, and allow it to switch 'off' and 'on.' This energy is stored up, every cycle of action of the apparatus, from the secondary circuit, by means of the two solenoids with sliding cores at the first moment of 'make.' We would also like to mention that the price of the switch, at present quoted (£10 10s.), will probably be greatly reduced."

New Issue.—The City of London Electric Lighting Company have brought out a prospectus offering for subscription 20,000 preference £10 shares at £2 per share premium. The objects of the company are well known, and the electric light in the City is growing into great popularity. Judging by the quotation of the shares on the Stock Exchange, and the general outlook of private lighting business for the company these shares will, we believe, be very fully subscribed, notwithstanding the 20 per cent. premium. The position of the company in regard to the works, and contracts and other information, is very minutely set forth in the prospectus, a copy of which will be found among our advertisements. The subscription list opened on Wednesday, and closes to-day (23rd inst.) at 4 p.m.

Brewery Electric Lighting.—The electric lighting of the Ajax Brewery, Richmond, Surrey, has been secured by Tickner and Partington, of Bristol House, Harlesden, N.W., and Lower Tottenham, N. It has been decided to use incandescent lamps for the inner illumination of the building, and for the court-yard it has been proposed to adopt arc lighting. On the roof arcs are to be arranged to throw light on to a large signboard, permitting of the same being read at some considerable distance, and from the river. The power will be supplied from an independent plant.

Electrical Engineer Wanted.—The Vestry of St. Mary, Islington, is prepared to receive applications for the appointment of electrical engineer. Candidates must be competent to prepare plans and specifications in connection with the installation about to be carried out in the parish, and to advise the vestry generally upon the details of the system of distribution. The gentleman appointed will be required to supervise the construction of the proposed central station and other works in connection therewith, and to take charge of such station when completed.

Drake & Gorham.—The contract for the lighting of the Manchester and Salford Savings Bank has been placed with this firm. The plant will consist of a 6 H.P. Otto gas engine, Electric Construction Corporation dynamo, and a battery of D.P. accumulators, capable of supplying 60 16-C.P. lamps for 9 hours without aid from the engine. The number of lights to be at present installed is 130 of varying candle power. Messrs. Drake & Gorham are also arranging for the lighting of the private house in connection with the bank.

A Good Dividend.—Mr. Rankin Kennedy, late of Carntyne Electric Works, Glasgow, has presented a petition to the Sheriff of Lanarkshire, at Glasgow, to be finally discharged of all debts contracted by him, or for which he was liable at the date of the sequestration of his estates. It is somewhat gratifying to learn, in connection with the liquidation of Mr. Kennedy's business, that his creditors have received a dividend at the rate of 19s. in the pound.

The South Staffordshire Electric Lighting Company, Limited.—A general meeting of the above-named company will be held at the offices of Carter, Carter, and Martineau, 33, Waterloo Street, Birmingham, on July 22nd, 1893, at noon precisely, for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted, and the property of the company disposed of.

Lists, &c.—An illustrated price list of switches, electric bells, fuses, brackets, and other electrical fittings, dated June, 1893, has been published by Messrs. John Davis and Son, of Derby.

Messrs. W. F. Dennis have forwarded to us one of Messrs. Felten and Guilleaume's latest price lists (sheet No. 3, June, 1893), of iron and steel wire, wire fencing accessories, wire mats, barb wires, telegraph wires, &c.

A new catalogue has been published by the Electrical Power Storage Company, Limited. This, as one would naturally assume, is descriptive of the various types of E P.S. cells, and various sundries connected therewith. In every respect the book has been well prepared, and the matter very neatly arranged; the paper is of the best quality, and the printing has been very well executed. Some interesting and instructive remarks regarding the mode of erection of and details as to working the batteries, as well as some particulars on the subjects of renewals, exchanges, and the supply of acid for the E P.S. apparatus are no unimportant features. The catalogue bears signs of much expense and labour having been devoted to it.

Change of Address.—In consequence of the rapid growth of their business, the International Electric Company removed on the 21st instant to more commodious premises, at 55, Redcross Street, Barbican, E.C. The electric light fittings department will be enlarged, and, eventually, the firm proposes to make a stock feature of Edison incandescent lamps. An elaborate showroom is being fitted up.

An Electrical Engineer's Failure.—The failure was announced at the London Bankruptcy Court last Wednesday, of Frederick Laurence Rawson, described as of 3, Kensington Court, W., electrical and mechanical engineer. The receiving order was made upon the petition of creditors, and no particulars transpired with regard to liabilities and assets.

Personal.—Mr. A. G. Sanders, A.I.E.E., who has been for many years on the staff of Messrs. Drake and Gorham as engineer, and in charge of the estimating department, has now severed his connection with them, and joined the firm of Messrs. B. Verity and Sons, representing them in a similar capacity in their Manchester business.

Nottingham Exhibition.—It has been arranged to light the Victoria Halls throughout by electricity, the dynamos, &c., being supplied by Messrs. Defries & Co., of London, and the motive power by the Trent Gas Engine Company, Limited.

Royal Agricultural Show, Chester.—Messrs. Carrick and Ritchie, of Edinburgh, exhibit at the above show, a collection of machinery for utilising water for power, consisting of various types of turbines and water motors.

Aberdeen Electric Lighting.—The Town Council are open to receive applications for the appointment of electrical engineer. Further information will be found among our advertisements.

Gilbert & Co.—This firm have secured the contract for electric lighting the extensive Philharmonic Restaurant at Cardiff. They are also very busy in both the City and West End districts.

CITY NOTES.

Printing Telegraph and Construction Company, Limited.

THE statutory general meeting of this company was held on Wednesday, June 14th, at the offices, 12, King William Street, E.C., the chairman (Col. W. J. Engledue), presiding. He pointed out that although the usual four months from registration had not yet passed, it had been thought advisable to convene the statutory meeting at the present time, to explain to the shareholders the present position of the company, and the difficulties which had arisen from hesitation on the part of a considerable proportion of those who undertook to subscribe the necessary capital to meet their obligations. They went to allotment on applications for 12,177 shares, representing £60,885, but several subscribers had failed to pay, and legal proceedings had been instituted against the defaulters to compel them to pay, in order that the objects of the company might be carried out. The result of these disappointments had been to prevent immediate settlement with the vendors and promoters, and consequent acquisition of the patent by their company, as the vendors had to pay the patentee £7,000 in cash, and a proportion of their fully-paid shares. The patentee's contract with the vendors terminated on May 10th, and, after waiting some time, he had cancelled his agreement with them. On this the directors rescinded their original contract, and obtained the patent through another source without payment of any cash. The new vendor had, he was told, arranged to make over a proportion of his shares to such persons associated with the former vendors as might be worthy of this consideration, and he had also placed in trust £10,000 of his fully-paid shares to meet any deficiency in the subscription of the £40,000 working capital, in the event of the directors not being able to recover from the defaulting shareholders, thus materially assisting the company. The shareholders would, therefore, see that the French patent had been acquired on advantageous terms, and it only remained for the calls now due to be paid in order to enable them to proceed to a satisfactory issue. The Agence Havas, he explained, held the leading position in France as a news agency, and was probably the only organisation to which the French Government would grant such concessions as have rendered the formation of the company feasible. He believed rival agencies had endeavoured to obtain similar facilities, with the object of introducing inferior machines into Paris, and having failed in this, the result was an undercurrent of intrigue, having for its object the wrecking of their undertaking. On the company being registered, the Agence Havas received many applications for the printing telegraph machines, but when complications arose which seemed to threaten indefinite delay, they had to stop taking orders. He now produced a list—which was open for the inspection of the shareholders—signed by the Agence Havas, showing 66 actual subscribers, with a rental of 105,700 fr., or an average of 1,600 fr., being more than was estimated in their prospectus. All subscribers pay in advance on receipt of machines, and they were therefore commencing business on favourable terms. Under all existing circumstances, it was thought advisable not to estimate for more than 125 machines at first; but these would be arranged on 10 circuits, which would accommodate more machines as they might be required. Tenders were being invited for the necessary cables in Paris, and the machines were in course of construction in New York, where they would be exhaustively tested before being sent on to Paris. If the shareholders would only come forward at once and meet their obligations, the first installation could be completed within about four months from date, but any delay incurred now would be most serious, for the directors would hesitate to accept tenders or to incur any expense, whilst those who had promised to subscribe would naturally feel uneasy, and the Agence Havas would be prevented from pushing the business amongst their clients. In reply to a question put by Count Max Hollender, the chairman stated that the cost of laying down 125 machines, inclusive of cable and other expenses, would be about £10,000. It was proposed to make a call of £1 per share at once, and another call of £1 per share in about two months' time. The chairman also stated that Mr. C. Cammell, one of the original directors, had resigned in consequence of not being able to devote sufficient time to the affairs of the company, and that Count Max Hollender had consented to consider if he could fill the vacancy.

Count HOLLENDER remarking that he was not anxious to join the board, and only proposed doing so because several of his friends were large shareholders,

Mr. BEYFUS remarked that there were two vacancies on the board, and that he thought Sir Augustus Harris, who knew Paris thoroughly, might be appointed.

The meeting concluded with a vote of thanks to the chairman and the board.

The Electric and General Investment Company, Limited.

THE directors' report, to be submitted to the fourth ordinary general meeting of the shareholders to be held at Winchester House, Old Broad-street, E.C., on Tuesday, June 27th, 1893, at 3.30 p.m., reads as follows:—

"The directors beg to submit the balance-sheet and profit and loss account for the year ended May 31st, 1893. The profit and loss account shows a gross profit on the transactions of the year of £11,092 15s. 4d., and after deducting all standing charges there remains a net balance available for distribution of £6,065 16s. 5d. An interim dividend has already been paid on the ordinary shares for the first six months of the year at the rate of 20 per cent. per annum, and the directors now recommend the payment of a further dividend upon the ordinary shares at the rate of 30 per cent. per annum for the past six months, and a dividend on the founders' shares of £30 per share. This will leave a balance of £65 16s. 5d., which the directors recommend should be carried forward in equal moieties on account of the ordinary shareholders and founders. Mr. George Herring has been elected chairman of the company in succession to the late Duke of Marlborough, whose death the directors deeply regret. The directors who retire this year are Lord Cloncurry and Mr. Braithwaite, but being duly eligible, they offer themselves for re-election. The auditors, Messrs. Rait and Kearton, also retire, but offer themselves for re-election. It is proposed to make the dividends payable on July 1st, 1893.

Western Union Telegraph Company.—The estimated net receipts for the quarter ending June 30th amount to $1,750,000, and the nominal surplus accumulated, after providing for the dividend, is increased to $6,920,313 from $6,689,818 at the end of March last. The board have declared their usual quarterly dividend of 1¼ per cent.

The West Coast of America Telegraph Company.—Coupons due June 30th, 1893, on the debentures of this company, will be paid by Messrs. Barclay & Co., Lombard Street. Coupons should be left two clear days for examination.

Hobart Electric Tramway Company.—The interest on coupon No. 3 of the first and second mortgage debentures will be payable on and after July 1st next at the Commercial Bank of Scotland, Lombard Street, E.C.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 18th, 1893, amounted to £782; week ending June 19th, 1892, £771; increase £11; total receipts for half-year, 1893, £21,034; corresponding period, 1892, £19,385; increase £1,649.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,867.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, June 15th.	Closing Quotation June 22nd.	Business done during week ended June 22nd, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	103½	...
1,134,640*l*	Anglo-American Telegraph, Limited	Stock	51½— 52½	51 — 52	51⅝	51
2,932,680*l*	Do. do. 6 p. c. Preferred	Stock	94 — 95	94½— 95½	95½	94½
2,876,140*l*	Do. do. Deferred	Stock	11½— 12	10⅞— 11⅛	11⅛	11⅛
130,000	Brazilian Submarine Telegraph, Limited	10	11⅞— 12¼	11⅞— 12¼	12⅛	12
36,400*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3¼	...	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2⅛— 2⅜	2⅜	2⅛
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	107 —109	108⅜	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	1½— 2½	2 — 3	...	...
630,000*l*	City and South London Railway	Stock	37 — 39	37 — 39	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½— 12	11½— 12	11⅝	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12½— 13	12½— 12⅞	12⅞	12⅜
$7,716,000	Commercial Cable, Capital Stock	$100	... ... xd	138 —142 xd	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16— 5/16xd	3/16— 5/16xd	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 5⅝	5½— 5⅝	...	...
16,000	Cuba Telegraph, Limited	10	11½— 12½	11½— 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18½— 19½	18½— 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅝— 12	11⅞— 12⅛	12 1/16	11 13/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15⅜— 15⅝	15 — 15¼	15⅛	15 1/16
70,000	Do. 6 p. c. Preference	10	16⅝— 17½	16⅜— 17½	16⅝	16 1/16
105,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,194,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	114½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝— 15⅞	15⅝— 15⅞	15 15/16	15⅝
70,600*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	104 —107	104 —107	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	107	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	112 —115	113 —116	115	...
108,700*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	103 —106	103 —106	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	104½	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	103½	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	2 — 2½	1⅞— 2¼	2¼	2 1/16
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛— ¼	⅛— ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅜— ⅝	⅜— ⅝	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛— ⅜	⅛— ⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 10	9¼— 10	10	9⅝
150,042	Do. do. 6 p. c. Preference	10	15⅝— 15⅞	15⅝— 15⅞	15⅞	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	19½— 20	19¾— 20½	19½	19⅞
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	106	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½— 7½	6½— 7½	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22½— 23½	22½— 23½	23⅜	23 5/16
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 43	39 — 42	40⅜	39⅜
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4 5/16— 4 7/16	4 5/16— 4 7/16	4 7/16	4 7/16
10,000	Do. do. fully paid	5	6⅜— 6⅝	6⅜— 6⅝	6⅝	5⅝
37,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6 — 6½	6 — 6½	6 5/16	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1½— 2½	1½— 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	5⅛— 5⅜	5⅛— 5⅜	5⅜	5 3/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14¾— 15½	14¾— 15½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14½— 14⅞	14½— 14⅞	...	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅜— 5⅝	5⅜— 5⅝	5 9/16	5 7/16
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —117	113 —117	...	...
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ¼	⅛ — ¼	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	101 —104	101 —104	...	...
11,802	Reuter's Limited	8	5½— 6¼xd	5 — 6 xd	5⅜	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¼— 7⅜	7¼— 7⅜	..	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8⅛	8 — 8⅛	...	...
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2½— 3 xd	2 — 2½ xd	2½	2⅛
37,350	Telegraph Construction and Maintenance, Limited	12	33 — 35	33 — 35	34½	34
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3	2½— 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½— 6½	5½— 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	103 —107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7¼— 7⅜	7¼— 7⅜	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1¼— 2	1½— 2	2	...
178,200*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
222,700*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	..
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1⅝	1½	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10⅜— 11¼	10⅜— 11¼	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9½— 10½	9½— 10½	9½	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
49,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½— 5⅝	5½— 5⅝	5½	...

*Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5½—6¼.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid) 1¾—2¼.—Founders' shares, £60—£65.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1¼—2¼.—Do. 7 per cent. Preference of £5, 5—5⅜.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 6⅛—6⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ¼—⅝.—Queen Anne's Mansions Lighting and Heating 6 per cent. £10 Debentures, 101—103. Bank rate of discount, 2½ per cent. (June 15th, 1893).

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.*

BY NIKOLA TESLA.

(*Continued from page* 716.)

In the diagrammatical sketch, fig. 1, which has been already referred to, the cases which are most likely to be met with in practice are illustrated. One has at his disposal either direct or alternating currents from a supply station. It is convenient for an experimenter in an isolated laboratory to employ a machine, G, such as illustrated, capable of giving both kinds of currents. In such case it is also preferable to use a machine with multiple circuits, as in many experiments it is useful and convenient to have at one's disposal currents of different phases. In the sketch, D represents the direct, and A the alternating circuit. In each of these, three branch circuits are shown, all of which are provided with double lines switches, *s*, *s*, *s*, *s*, *s*, *s*. Consider, first, the direct current conversion; 1, *a* represents the simplest case. If the E.M.F. of the generator is sufficient to break through a small air space, at least when the latter is warmed or otherwise rendered poorly insulating, there is no difficulty in maintaining a vibration with fair economy by judicious adjustment of the capacity, self-induction and resistance of the circuit, L, containing the devices, *l*, *l*, *m*. The magnet, N, S, can be in this case advantageously combined with the air space. The discharger, *d*, *d*, with the magnet may be placed either way, as indicated by the full or by the dotted lines. The circuit, 1, *a*, with the connections and devices is supposed to possess dimensions such as are suitable for the maintenance of a vibration. But usually the E.M.F. on the circuit or branch, 1, *a*, will be something like 100 volts or so, and in this case it is not sufficient to break through the gap. Many different means may be used to remedy this by raising the E.M.F. across the gap. The simplest is probably to insert a large self-induction coil in series with the circuit, L. When the arc is established, as by the discharger illustrated in fig. 2, the magnet blows the arc out the instant it is formed. Now the extra current of the break, being of high E.M.F., breaks through the gap, and a path of low resistance for the dynamo current being again provided, there is a sudden rush of the current from the dynamo upon the weakening or subsidence of the extra current. This process is repeated in rapid succession, and in this manner I have maintained oscillation with as low as 50 volts, or even less, across the gap. But conversion on this plan is not to be recommended on account of the too heavy currents through the gap and consequent heating of the electrodes; besides, the frequencies obtained in this way are low, owing to the high self-induction necessarily associated with the circuit. It is very desirable to have the E.M.F. as high as possible, first, in order to increase the economy of the conversion, and, secondly, to obtain high frequencies. The difference of potential in this electric oscillation is, of course, the equivalent of the stretching force in the mechanical vibration of the spring. To obtain very rapid vibration in a circuit of some inertia a great stretching force or difference of potential is necessary. Incidentally, when the E.M.F. is very great, the condenser which is usually employed in connection with the circuit need have but a small capacity, and many other advantages are gained. With a view of raising the E.M.F. to a many times greater value than obtainable from ordinary distribution circuits, a rotating transformer, *g*, is used, as indicated in fig. 2*a*, or else a separate high potential machine is driven by means of a motor operated from the generator, G. The latter plan is in fact preferable, as changes are easier made. The connections from the high tension winding are quite similar to those in branch 1*a*, with the exception that a condenser, C, which should be adjustable, is connected to the high tension circuit. Usually, also, an adjustable self-induction coil in series with the circuit has been employed in these experiments. When the tension of the currents is very high the magnet ordinarily used in connection with the discharger is of comparatively small value, as it is quite easy to adjust the dimensions of the circuit so that oscillation is maintained. The employment of a steady E.M.F. in the high frequency conversion affords some advantages over the employment of alternating E.M.F. as the adjustments are much simpler and the action can be easier controlled. But unfortunately one is limited by the obtainable potential difference. The windings also break down easily in consequence of the sparks which form between the sections of the armature or commutator when a vigorous oscillation takes place. Besides, these transformers are expensive to build. It has been found by experience that it is best to follow the plan illustrated in fig. 3*a*. In this arrangement a rotating transformer, *g*, is employed to convert the low tension direct currents into low frequency alternating currents, preferably also of small tension. The tension of the currents is then raised in a stationary transformer, T. The secondary, S, of this transformer is connected to an adjustable condenser, C, which discharges through the gap or discharger, *d*, *d*, placed in either of the ways indicated, through the primary, P, of a disruptive discharge coil, the high frequency currents being obtained from the secondary, S, of this coil, as described on previous occasions. This will undoubtedly be found the cheapest and most convenient way of converting direct currents.

The three branches of the circuit, A, represent the usual cases met in practice when alternating currents are converted. In fig. 1*b* a condenser, C, generally of large capacity, is connected to the circuit, L, containing the devices, *l*, *l*, *m*, *m*. The devices, *m*, *m*, are supposed to be of high self-induction so as to bring the frequency of the circuit more or less to that of the dynamo. In this instance the discharger, *d*, *d*, should best have a number of makes and brakes per second equal to twice the frequency of the dynamo. If not so, then it should have at least a number equal to a multiple or even fraction of the dynamo frequency. It should be observed, referring to 1*b*, that the conversion to a high potential is also effected when the discharger, *d*, *d*, which is shown in the sketch, is omitted. But the effects which are produced by currents which rise instantly to high values, as in a disruptive discharge, are entirely different from those produced by dynamo currents which rise and fall harmonically. So, for instance, there might be in a given case a number of makes and breaks at *d*, *d*, equal to just twice the frequency of the dynamo, or, in other words, there may be the same number of fundamental oscillations as would be produced without the discharge gap, and there might even not be any quicker superimposed vibrations; yet the differences of potential at the various points of the circuit, the impedence and other phenomena dependent upon the rate of change, will bear no similarity in the two cases. Thus, when working with currents discharging disruptively, the element chiefly to be considered is not the frequency, as a student might be apt to believe, but the rate of change per unit of time. With low frequencies in a certain measure the same effects may be obtained as with high frequencies, provided the rate of change is sufficiently great. So if a low frequency current is raised to a potential of, say, 75,000 volts, and the high tension current passed through a series of high resistance lamp filaments, the importance of the rarefied gas surrounding the filament is clearly noted, as will be seen later; or, if a low frequency current of several thousand ampères is passed through a metal bar striking phenomena of impedence are observed, just as with currents of high frequencies. But it is, of course, evident that with low frequency currents it is impossible to obtain such rates of change per unit of time as with high frequencies, hence the effects produced by the latter are much more prominent. It was deemed advisable to make the preceding remarks, inasmuch as many more recently described effects have been unwittingly identified with high frequencies. Frequency alone in reality does not mean anything, except when an undisturbed harmonic oscillation is considered.

In the branch 3*b* a similar disposition as in 1*b* is illustrated, with the difference that the currents discharging through the gap, *d*, *d*, are used to induce currents in the secondary, S, of a transformer, T. In such case the secondary should be provided with an adjustable condenser for the purpose of tuning it to the primary.

Fig. 2*b* illustrates a plan of alternate current high frequency conversion which is most frequently used, and which is found to be most convenient. This plan has been dwelt upon in detail on previous occasions, and need not be described here.

Some of these results were obtained by the use of a high frequency alternator. A description of such machines will be found in my original paper before the American Institute of Electrical Engineers, and in periodicals of that period, notably, in the *Electrical Engineer* of March 18th, 1891.

I will now proceed with the experiments.

ON PHENOMENA PRODUCED BY ELECTROSTATIC FORCE.

The first class of effects I intend to show you are effects produced by electrostatic force. It is the force which governs the motion of the atoms, which causes them to collide and develop the life-sustaining energy of heat and light, and which causes them to aggregate in an infinite variety of ways, according to Nature's fanciful designs, and to form all these wondrous structures we perceive around us; it is, in fact, if our present views be true, the most important force for us to consider in Nature. As the term *electrostatic* might imply a steady electric condition, it should be remarked that in these experiments the force is not constant, but varies at a rate which may be considered moderate, about one million times a second, or thereabouts. This enables me to produce many effects which are not producible with an unvarying force.

When two conducting bodies are insulated and electrified, we say that an electrostatic force is acting between them. This force manifests itself in attractions, repulsions and stresses in the bodies and space or medium without. So great may be the strain exerted in the air, or whatever separates the two conducting bodies, that it may break down, and we observe sparks or bundles of light or streamers, as they are called. These streamers form abundantly when the force through the air is rapidly varying. I will illustrate this action of electrostatic force in a novel experiment in which I will employ the induction coil before referred to. The coil is contained in a trough filled with oil, and placed under the table. The two ends of the secondary wire pass through the two thick columns of hard rubber, which protude to some height above the table. It is necessary to insulate the ends or terminals of the secondary heavily with hard rubber, because even dry wood is by far too poor an insulator for these currents of enormous potential differences. On one of the terminals of the coil I have placed a large sphere of sheet brass, which is connected to a larger insulated brass plate, in order to enable me to perform the experiments under conditions which, as you will see, are more suitable for this experiment. I now set the coil to work and approach the free terminal with a metallic object held in my hand, this simply to avoid burns. As I approach the metallic object to a distance of 8 or 10 inches, a torrent of furious sparks breaks forth from the end of the secondary wire, which passes through the rubber column. The sparks cease when the metal in my hand touches the wire. My arm is now traversed by a powerful electric current, vibrating at about the rate of one million times a second. All around me the electrostatic force makes itself felt, and the air molecules and particles of dust flying about are acted upon and are hammering violently against my body. So great is this agitation of the particles, that when the lights are turned out you may see streams of feeble light appear on some parts of my body.

* A lecture delivered before the Franklin Institute, at Philadelphia, February 24th, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1st, 1893.

When such a streamer breaks out on any part of the body it produces a sensation like the pricking of a needle. Were the potentials sufficiently high and the frequency of the vibration rather low, the skin would probably be ruptured under the tremendous strain, and the blood would rush out with great force in the form of fine spray or jet so thin as to be invisible, just as oil will when placed on the positive terminal of a Holtz machine. This breaking through of the skin, though it may seem impossible at first, would perhaps occur by reason of the tissues under the skin being incomparably better conducting. This, at least, appears plausible, judging from some observations.

I can make these streams of light visible to all, by touching with the metallic object one of the terminals as before, and approaching my free hand to the brass sphere, which is connected to the second terminal of the coil. As the hand is approached the air between it and the sphere, or in the immediate neighbourhood, is more violently agitated, and you see streams of light now break forth from my finger tips and from the whole hand (fig. 5). Were I to approach the

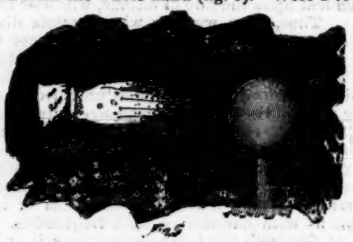


Fig 5

ILLUSTRATING THE EFFECT OF VARYING ELECTROSTATIC FORCE WITH A TRANSFORMER OF 200,000 VOLTS PRESSURE.

hand closer, powerful sparks would jump from the brass sphere to my hand, which might be injurious. The streamers offer no particular inconvenience, except that in the ends of the finger tips a burning sensation is felt. They should not be confounded with those produced by the influence machine, because in many respects they behave differently. I have attached the brass sphere and plate to one of the terminals in order to prevent the formation of visible streamers on that terminal, also in order to prevent sparks from jumping at a considerable distance. Besides, the attachment is favourable for the working of the coil.

The streams of light which you have observed issuing from my hand are due to a potential of about 200,000 volts, alternating in rather irregular intervals, something like a million times a second. A vibration of the same amplitude, but four times as fast, to maintain which over 3,000,000 volts would be required, would be more than sufficient to envelop my body in a complete sheet of flame. But this flame would not burn me up; quite contrarily; the probability is that I would not be injured in the least. Yet a hundrdth part of that energy, otherwise directed, would be amply sufficient to kill a person.

The amount of energy which may thus be passed into the body of a person depends on the frequency and potential of the currents, and by making both of these very great, a vast amount of energy may be passed into the body without causing any discomfort, except, perhaps, in the arm, which is traversed by a true conduction current. The reason why no pain in the body is felt, and no injurious effect noted, is that everywhere, if a current be imagined to flow through the body, the direction of its flow would be at right angles to the surface; hence the body of the experimenter offers an enormous section to the current, and the density is very small, with the exception of the arm, perhaps, where the density may be considerable. But if only a small fraction of that energy should be applied in such a way that a current would traverse the body in the same manner as a low frequency current, a shock would be received which might be fatal. A direct or low frequency alternating current is fatal, I think, principally because its distribution through the body is not uniform, as it must divide itself in minute streamlets of great density, whereby some organs are vitally injured. That such a process occurs I have

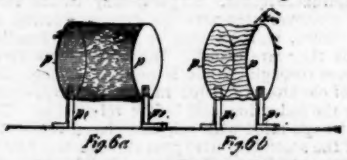


Fig 6a Fig 6b

ILLUSTRATING THE EFFECTS OF RAPIDIY VARYING AND STEADY ELECTROSTATIC FORCE.

not the least doubt, though no evidence might apparently exist, or be found upon examination. The surest to injure and destroy life is a continuous current, but the most painful is an alternating current of very low frequency. The expression of these views, which are the result of long continued experiment and observation, both with steady and varying currents, is elicited by the interest which is at present taken in this subject, and by the manifestly erroneous ideas which are daily propounded in journals on this subject.

I may illustrate an effect of the electrostatic force by another striking experiment, but before, I must call your attention to one or two facts. I have said before, that when the medium between two oppositely electrified bodies is strained beyond a certain limit it gives way, and, stated in popular language, the opposite electric charges unite and neutralise each other. This breaking down of the medium occurs principally when the force acting between the bodies is steady, or varies at a moderate rate. Were the variation sufficiently rapid, such a destructive break would not occur, no matter how great the force, for all the energy would be spent in radiation, convection, and mechanical and chemical action. Thus the *spark* length, or greatest distance through which a *spark* will jump between the electrified bodies is the smaller, the greater the variation or time rate of change. But this rule may be taken to be true only in a general way, when comparing rates which are widely different.

I will show you by an experiment the difference in the effect produced by a rapidly varying and a steady or moderately varying force. I have here two large circular brass plates, *p*, *p* (fig. 6*a* and fig. 6*b*), supported on movable insulating stands on the table, connected to the ends of the secondary of a similar coil as the one used before. I place the plates ten or twelve inches apart and set the coil to work. You see the whole space between the plates, nearly 2 cubic feet, filled with uniform light fig. 6*a*. This light is due to the streamers you have seen in the first experiment, which are now much more intense. I have already pointed out the importance of these streamers in commercial apparatus and their still greater importance in some purely scientific investigations. Often they are too weak to be visible, but they always exist, consuming energy and modifying the action of the apparatus. When intense, as they are at present, they produce ozone in great quantity, and also, as Prof. Crookes has pointed out, nitrous acid. So quick is the chemical action, that if a coil such as this one, is worked for a very long time it will make the atmosphere of a small room unbearable, for the eyes and throat are attacked. But when moderately produced, the streamers refresh the atmosphere wonderfully, like a thunderstorm, and exercise unquestionably a beneficial effect.

In this experiment the force acting between the plates changes in intensity and direction at a very rapid rate. I will now make the rate of change per unit time much smaller. This I effect by rendering the discharges through the primary of the induction coil less frequent, and also by diminishing the rapidity of the vibration in the secondary. The former result is conveniently secured by lowering the E.M.F. over the air gap in the primary circuit, the latter, by approaching the two brass plates to a distance of about 3 or 4 inches. When the coil is set to work you see no streamers or light between the plates, yet the medium between them is under a tremendous strain. I still further augment the strain by raising the E.M.F. in the primary circuit, and soon you see the air give way and the ball is illuminated by a shower of brilliant and noisy sparks, 6*b*. These sparks could be produced also with unvarying force; they have been for many years a familiar phenomenon, though they were usually obtained from entirely different apparatus. In describing these two phenomena so radically different in appearance, I have advisedly spoken of a "force" acting between the plates. It would be in accordance with accepted views to say, that there was an "alternating E.M.F." acting between the plates. This term is quite proper and applicable in all cases where there is evidence of at least a possibility of an essential inter-dependence of the electric state of the plates, or electric action in their neighbourhood. But if the plates were removed to an infinite distance, or if at a finite distance, there is no probability or necessity whatever for such dependence. I prefer to use the term "electrostatic force," and to say that such a force is acting around each plate or electrified insulated body in general. There is an inconvenience in using this expression as the term incidentally means a steady electric condition; but a proper nomenclature will eventually settle this difficulty.

I now return to the experiment to which I have already alluded, and with which I desire to illustrate a striking effect produced by a rapidly varying electrostatic force. I attach to the end of the wire, *l* (fig. 7), which is in connection with one of the terminals of the

Fig 7

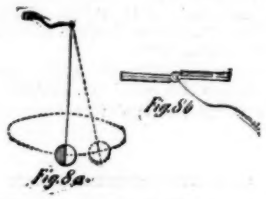
BREAKING A BULB ON OPEN CIRCUIT.

secondary of the induction coil, an exhausted bulb, *b*. This bulb contains a thin carbon filament, *f*, which is fastened to a platinum wire, *w*, sealed in the glass and leading outside of the bulb, where it connects to the wire, *l*. The bulb may be exhausted to any degree attainable with ordinary apparatus. Just a moment before, you have witnessed the breaking down of the air between the charged brass plates. You know that a plate of glass, or any other insulating material, would break down in like manner. Had I, therefore, a metallic coating attached to the outside of the bulb, or placed near the same, and were this coating connected to the other terminal of the coil, you would be prepared to see the glass give way if the strain were sufficiently increased. Even were the coating not connected to the other terminal, but to an insulated plate, still, if you have followed recent developments, you would naturally expect a rupture of the glass.

But it will certainly surprise you to note that under the action of the varying electrostatic force the glass gives way when all other bodies are removed from the bulb. In fact, all the surrounding bodies

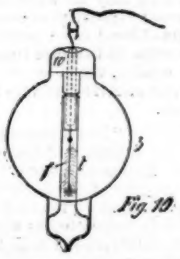
we perceive might be removed to an infinite distance without affecting the result in the slightest. When the coil is set to work, the glass is invariably broken through at the seal, or other narrow channel, and the vacuum is quickly impaired. Such a damaging break would not occur with a steady force, even if the same were many times greater. The break is due to the agitation of the molecules of the gas within the bulb, and outside the same. This agitation, which is generally most violent in the narrow pointed channel near the seal, causes a heating and rupture of the glass. This rupture would, however, not occur, not even with a varying force, if the medium filling the inside of the bulb, and that surrounding it, were perfectly homogeneous. The break occurs much quicker if the top of the bulb is drawn out into a fine fibre. In bulbs used with these coils such narrow pointed channels must, therefore, be avoided.

When a conducting body is immersed in air, or similar insulating medium, consisting of, or containing, small freely movable particles capable of being electrified, and when the electrification of the body is made to undergo a very rapid change—which is equivalent to saying that the electrostatic force acting around the body is varying in intensity—the small particles are attracted and repelled, and their violent impacts against the body may cause a mechanical motion of the latter. Phenomena of this kind are noteworthy, inasmuch as they have not been observed before with apparatus such as has been commonly in use. If a very light conducting sphere be suspended on an exceedingly fine wire, and charged to a steady potential, however high, the sphere will remain at rest. Even if the potential would be rapidly varying, provided that the small particles of matter, molecules or atoms, are evenly distributed, no motion of the sphere should result. But if one side of the conducting sphere is covered with a thick insulating layer, the impacts of the particles will cause the sphere to move about, generally in irregular curves, fig. 8*a*. In like manner, as I have shown on a previous occasion, a fan of metal sheet, fig. 8*b*, covered partially with insulating material as indicated, and placed upon the terminal of the coil so as to turn freely in it, is spun around.



MECHANICAL MOTIONS PRODUCED BY VARYING ELECTROSTATIC FORCE IN A GASEOUS MEDIUM.

All these phenomena you have witnessed, and others which will be shown later, are due to the presence of a medium like air, and would not occur in a continuous medium. The action of the air may be illustrated still better by the following experiment. I take a glass tube, *t*, fig. 9, of about an inch in diameter, which has a platinum



SHOWING THE INFLUENCE OF THE CONDUCTIVITY OF THE MEDIUM UPON ELECTROSTATIC ACTIONS THROUGH MEASURABLE DISTANCE.

SHOWING THE EFFECT OF THE AIR.

wire, *w*, sealed in the lower end, and to which is attached a thin lamp filament, *f*. I connect the wire with the terminal of the coil, and set the coil to work. The platinum wire is now electrified positively and negatively in rapid succession, and the wire and air inside of the tube is rapidly heated by the impacts of the particles, which may be so violent as to render the filament incandescent. But if I pour oil in the tube, just as soon as the wire is covered with the oil, all action apparently ceases, and there is no marked evidence of heating. The reason of this is that the oil is a practically continuous medium. The displacements in such a continuous medium are, with these frequencies, to all appearance incomparably smaller than in air, hence the work performed in such a medium is insignificant. But oil would behave very differently with frequencies many times as great, for even though the displacements be small, if the frequency were much greater, considerable work might be performed in the oil.

The electrostatic attractions and repulsions between bodies of measurable dimensions are, of all the manfestations of this force, the first so-called *electrical* phenomena noted. But though they have been known to us for many centuries, the precise nature of the mechanism concerned in these actions is still unknown to us, and has not been even quite satisfactorily explained. What kind of mechanism must that be? We cannot help wondering when we observe two magnets attracting and repelling each other with a force of hundreds of pounds with apparently nothing between them. We have in our commercial dynamos magnets capable of sustaining in mid-air tons of weight. But what are even these forces acting between magnets when compared with the tremendous attractions and repulsions produced by electrostatic force, to which there is apparently no limit as to intensity. In lightning discharges bodies are often charged to so high a potential that they are thrown away with inconceivable force and torn asunder or shattered into fragments. Still, even such effects cannot compare with the attractions and repulsions which exist between charged molecules or atoms, and which are sufficient to project them with speeds of many kilometres a second, so that under their violent impact bodies are rendered highly incandescent and are volatilised. It is of special interest for the thinker who inquires into the nature of these forces to note, that whereas the actions between individual molecules or atoms occur seemingly under any condition, the attractions and repulsions of bodies of measurable dimensions imply a medium possessing insulating properties. So, if air, either by being rarefied or heated, is rendered more or less conducting, these actions between two electrified bodies practically cease, while the actions between the individual atoms continue to manifest themselves.

An experiment may serve as an illustration and as a means of bringing out other features of interest. Some time ago I showed that a lamp filament or wire mounted in a bulb and connected to one of the terminals of a high tension secondary coil is set spinning, the top of the filament generally describing a circle. This vibration was very energetic when the air in the bulb was at ordinary pressure and became less energetic when the air in the bulb was strongly compressed. It ceased altogether when the air was exhausted so as to become comparatively good conducting. I found at that time that no vibration took place when the bulb was very highly exhausted. But I conjectured that the vibration which I ascribed to the electrostatic action between the walls of the bulb and the filament should take place also in a highly exhausted bulb. To test this under conditions which were more favourable, a bulb like the one in fig. 10 was constructed. It comprised a globe, *b*, in the neck of which was sealed a platinum wire, *w*, carrying a thin lamp filament, *f*. In the lower part of the globe a tube, *t*, was sealed so as to surround the filament. The exhaustion was carried as far as it was practicable with the apparatus employed.

This bulb verified my expectation, for the filament was set spinning when the current was turned on, and became incandescent. It also showed another interesting feature, bearing upon the preceding remarks, namely, when the filament had been kept incandescent some time, the narrow tube and the space inside was brought to an elevated temperature, and as the gas in the tube then became conducting, the electrostatic attraction between the glass and the filament became very weak or ceased and the filament came to rest. When it came to rest it would glow far more intensely. This was probably due to its assuming the position in the centre of the tube where the molecular bombardment was most intense, and also partly to the fact that the individual impacts were more violent and that no part of the supplied energy was converted into mechanical movement. Since, in accordance with accepted views, in this experiment the incandescence must be attributed to the impacts of the particles, molecules or atoms in the heated space, these particles must therefore, in order to explain such action, be assumed to behave as independent carriers of electric charges immersed in an insulating medium; yet there is no attractive force between the glass tube and the filament because the space in the tube is, as a whole, conducting.

It is of some interest to observe in this connection that whereas the attraction between two electrified bodies may cease owing to the impairing of the insulating power of the medium in which they are immersed, the repulsion between the bodies may still be observed. This may be explained in a plausible way. When the bodies are placed at some distance in a poorly conducting medium, such as slightly warmed or rarefied air, and are suddenly electrified, opposite electric charges being imparted to them, these charges equalise more or less by leakage through the air. But if the bodies are similarly electrified, there is less opportunity afforded for such dissipation, hence the repulsion observed in such case is greater than the attraction. Repulsive actions in a gaseous medium are however, as Prof. Crookes has shown, enhanced by molecular bombardment.

(To be continued.)

FRENCH CABLES.*

THE important position occupied by telegraph cables has been but recently appreciated in France, although it is a question intimately connected with the extension of our colonial influence. English people, as usual, have been quicker to understand the value of cable communication, and it may be truthfully asserted that they hold in their grasp nearly all the principal international lines, more especially those which minister to our colonies.

Very little reflection is required to understand the many disadvantages, and even dangers, resulting from this condition of affairs. On the West Coast of Africa, for instance, we have endless disputes with the English Goverment upon territorial questions. Now, it is by means of English lines that the French Government and its agents are compelled to correspond! Further, we pay for this accommodation a very heavy tax, which forms the principal portion of the revenue earned by English lines. Would it not have been a hundred times better to have lent some assistance towards the creation of French lines?

* Extract from the *Politique Coloniale*.

We are only discussing the position in times of peace; should there be war, our possessions would be cut off from all communication with the metropolis, and they would be entangled in the meshes of a network of English cables!

The only important transatlantic line in our hands is the Télégraphe de Paris à New York, popularly known as the P.Q., from the name of the founder, Pouyer Quertier. Here again, the proprietors of the American competing lines (Mackay-Bennett) succeeded during latter years in introducing a council of administration devoted to American interests, and which governed the unfortunate French Company by methods contrary to all common sense. Happily, after interminable difficulties, the Americans, or their minions, were expelled from the management of the P. Q. cable, and were replaced by a council of administration entirely French, and composed of honest men. The council is composed of MM. de la Baumelle, Boulaire, de Carrère, Th. Cibiel, Chauvassaignes, Etard, S. Halphen, Lafargue, Lefaivre, Marquis de Lauris, and A. Pestel.

There are, however, two criticisms to be made with regard to this council. In the first place, it lacks independence, being completely in the hands of M. May, of the International Bank. In the second place (and this is a consequence of its position), although many of its members are without doubt very honest men, their past lives and their ability are not of a character to inspire confidence, and it is consequently not improbable that they may be unable to accomplish the difficult task which the council finds awaiting it.

We shall, at another time, find an opportunity of reverting to this subject.

Here we have, at all events, a line reconquered; several others have been created by the French on the Coasts of South America and in the Mediterranean. The concession for the New Caledonia cable has been granted—an action which merits the warmest approval. But, if certain reports are to be believed, the Colonial Administration will be asked to grant to an English company the concession for a system of cables uniting Madagascar and Réunion with the Seychelles. We firmly believe that such a mistake will not be made; we have had enough of them in the past. The group of French possessions in the Indian Ocean is of sufficient importance to permit of a French system being established there while awaiting the time when this system may be connected to a more important cable, also French. We will show that this is both possible and necessary. But, meanwhile, we feel it to be our duty to place the Government on its guard against this fresh attempt at encroachment on the part of English companies.

NEW PATENTS—1893.

10,860. "Improvements in or relating to arc lamps." W. S. BOULT and C. R. BOULT. Dated June 5th.

10,887. "An improved system of town sewage disposal combined with production of electrical supply, and in means and apparatus therefor." W. H. HILL-HARTLAND. Dated June 5th.

10,888. "Telephone receiver and transmitter." A. E. MUIRHEAD. Dated June 5th.

10,937. "Improved electric meter." A. H. HOWARD. Dated June 5th.

10,942. "Improvements in primary voltaic batteries." W. WALKER, jun., and F. R. WILKINS. Dated June 5th.

10,963. "Electro-mechanical switch and system of electrical intercommunication." E. A. CLARK. Dated June 5th. (*Complete*)

10,965. "Improvements in insulating compounds." E. T. HUGHES. (Communicated by M. H. Devey, United States.) Dated June 5th.

10,976. "Improvements in apparatus for the electrolytical decomposition of brine and other liquids." M. GUTHRIE. Dated June 5th.

10,987. "Improvements in the electric propulsion of boats." F. R. BROWN. Dated June 5th.

10,993. "Improvements in electric search light apparatus." G. SCIAMA. Dated June 5th.

11,069. "Improvements in or relating to producing (or maintaining), continuous lines of telegraph wires, rails, pipes, and other metallic line structures, and in apparatus or devices connected therewith." W. P. THOMPSON. (Communicated by E. E. Ries and A. H. Henderson, United States.) Dated June 6th. (*Complete.*)

11,084. "Improvements in arc electric lamps." S. S. ALLIN. Dated June 6th.

11,092. "Improvements in electric batteries." M. L. M. HELLESEN, *née* BARNEKOW. Dated June 6th. (*Complete.*)

11,099. "Improvements in electric glow lamps." H. H. LAKE. (Communicated by E. A. Colby, United States.) Dated June 6th. (*Complete.*)

11,105. "Improvements in electrolytic apparatus." T. CRANEY. Dated June 6th. (*Complete.*)

11,106. "Improvements in electrolytic cells." T. CRANEY. Dated June 6th. (*Complete.*)

11,107. "Improvements in electrolytic apparatus." T. CRANEY. Dated June 6th. (*Complete.*)

11,108. "Improvements relating to the electrolysis of salts and to apparatus therefor." T. CRANEY. Dated June 6th. (*Complete.*)

11,122. "Improvements in secondary batteries or accumulators." A. E. PEYRUSSON. Dated June 6th. [Date applied for under Patents Act, 1883, Section 103, April 1st, 1893, being date of application in France.]

11,143. "Improvements in electrical switches, fuses, ceiling plates, wall connectors, and the like." C. M. DORMAN and R. A. SMITH. Dated June 7th. (*Complete.*)

11,168. "Improvements in arc lamps." B. DEATH. Dated June 7th.

11,176. "Improvements in electrical indicators." J. T. GENT, A. W. STAVELEY, and I. H. PARSONS. Dated June 7th.

11,177. "Improvements in fittings for electric glow lamps and in the means of producing the same for decorative and advertising purposes." P. WARD and E. COOPER. Dated June 7th.

11,183. "An improvement in grapnels for submarine cables." W. C. JOHNSON. Dated June 7th.

11,184. "Improvements in apparatus for effecting electrical communication between a number of separate stations or apartments with a central station or apartment." SIEMENS BROS. & CO., LIMITED. (Communicated by F. E. Morgan and H. E. Walter, United States.) Dated June 7th.

11,235. "An improvement in electric motor fans." J. A. WADE. Dated June 8th.

11,294. "Improvements in automatic electric exchange." R. PIPPETTE. Dated June 8th.

11,299. "An improved electro-magnetic machine or motor." M. R. VON LEON. Dated June 8th.

11,369. "An improved insulating compound and process of preparing same." A. GENTZSCH, J. GOLDSCHMIDT, and E. R. VON SCANAVI. Dated June 9th. (*Complete.*)

11,384. "Improved method of and apparatus for regulating the electromotive force of electrical generators." J. S. RAWORTH. Dated June 9th.

11,387. "Improvements in microphones." Sir C. S. FORBES, Bart. Dated June 9th.

11,391. "Improvements in electric motors and dynamo-electric machines." R. SHEPHERD. Dated June 10th.

11,426. "Electric motors." H. L. TODD and G. LEWIS. Dated June 10th.

11,427. "Improvements in and connected with electric accumulators or secondary batteries." J. C. HOWELL, R. E. B. CROMPTON, C. F. CLAUS, jun., and the CROMPTON-HOWELL ELECTRIC STORAGE COMPANY, LIMITED. Dated June 10th.

11,439. "An improved machine for giving electric shocks automatically by the insertion of a coin." G. BRYANT. Dated June 10th.

11,446. "An improved electrical foot warmer." W. E. ULMER. Dated June 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

17,042. "Improvements in and relating to dynamo-electric machines, applicable for the traction or propulsion of any vehicle, vessel, or body, as well as for all purposes to which dynamo-electric machines may be suitable." J. MACHAFFIE. Dated October 7th. Relates to spherical armature dynamo-electric machines, and it has for its object to so construct such machines, and the parts connected therewith, as to adapt them for the efficient traction or propulsion of any vehicle, vessel, or body, as well as for all purposes to which dynamo-electric machines in general are applied, or are suitable. 27 claims.

17,631. "Improvements in the process and apparatus for electrolytic manufacture of tubes, pans, and other bodies of circular form." A. S. ELMORE. Dated October 15th. Consists in arranging the moving gear of the burnisher, that, instead of its following merely a helical line along the surface of the deposited metal, it follows a line which is undulating as well as helical, that is to say, while it advances continuously, at the same time it oscillates in a longitudinal direction. 2 claims.

18,646. "Improvements in electric motors and dynamo machines." H. CHITTY. Dated October 29th. The essential feature of the invention consists:—In a machine which has an even number of magnets, or electro-magnets, arranged uniformly round a circle, forming an even number of successive fields of alternating polarity, and which depends for its action upon the difference between the number of its fields and coils, or poles, presented by its armature, in the reduction by the means herein set forth, of the necessary difference between the number of fields and armature coils, or poles, to the lowest possible limit, *i.e.* one, whereas in machines of present known construction the limit is two. 4 claims.

18,905. "Improvements in electric railway signals, parts of which are applicable to other signalling or alarm purposes." J. O. Y ESPINOSA. Dated November 2nd. Consists of a special system of electrical apparatus, which notifies not only the extreme stations of a portion of a road, but also the engine that runs over said road when another engine is coming in an opposite direction. 11 claims.

19,134. "Improvements in or relating to electric meters." F. TEAGUE. Dated November 5th. Relates to improvements in electric meters of the kind described in the specification to letters patent, No. 15,489, October 2nd, 1889, and to an application for letters patent, No. 389, bearing date January 8th, 1891. 8 claims.

19,176. "An improved method of and apparatus for producing rotating magnetic field and multiphase alternating currents." E. A. WAHLSTROM. Dated November 6th. Relates to an arrangement of the coils which are placed between coils the phase of magnetisation whereof differs by 90°; and to the employment of the same for machines and transformers. 2 claims.

19,554. "Improvements in electric switches." V. G. LIRONI.

Dated November 11th. Upon a suitable base are mounted one or more segments of brass, or other suitable metal, of a curved wedge-like section, so that they will have a slightly inclined surface. A brass arm is provided for connecting the segment or segments, and is mounted on a pivot in the centre of the base. The arm is held down by means of a suitable spring fixed to or contained within the base, and when leaving any of the segments, will be drawn down and break the circuit instantaneously. 3 claims.

19,972. "A new or improved device for varying the resistance in telephone circuits." E. L. MAYER. Dated November 17th. The inventor employs a carbon rod (or its equivalent) which he lays upon two conducting blocks in the same manner as a board is laid upon two trestles. One of these blocks he attaches to the diaphragm in the usual well known manner, and the other he attaches to the back of the instrument case or other convenient fixed part. 5 claims.

19,975. "Improvements in and relating to electric arc lamps or lighting apparatus." F. V. MAQUAIRE. Dated November 27th. The current which flows through the lamp runs through two solenoids. One of these is in the main circuit, and the other is in a circuit shunted from the arc. The combined action of these two solenoids is exerted on the same articulated parallelogram, which transmits to the parts of the lamp the variations of motive power produced by the current in the solenoids. 5 claims.

19,996. "Improvements in electric alarum clocks." J. NICHOLLS. Dated November 18th. The inventor employs an ordinary dry or "Leclanché" electric battery, enclosed in a suitable case or cover, and over which is fixed the alarum clock. The electric bell is attached to the front of the said case or cover and connected to the battery in the usual way. In connection with the alarum part of the clock he provides a small rod, which is moved by said alarum part on coming into action at the required or fixed time. The said small rod, on moving as aforesaid, causes a hammer to fall, which is forced downwards by a suitable spring onto a copper or brass piece, which is connected by a suitable wire to the battery, thus completing the electrical circuit and causing the electric bell to ring until the communication is broken by the switch, which is forced between the aforesaid hammer and copper or brass piece. 2 claims.

20,413. "Improved electrolytic apparatus, more particularly applicable for manufacturing caustic soda and other products from salt, but also applicable to other purposes." G. BAMBERG. Dated November 24th. Claim:—An electrolytic cell divided into two compartments, the one containing the anode, the other the cathode, communicating with one another by a passage formed by partitions or otherwise as an inverted syphon, having its mouths below the surface of the electrolytic liquid, substantially as and for the purpose set forth.

20,886. "Improvements in or connected with electric mast-head and side lights for ships." W. C. MARTIN and J. HUNTER. Dated December 1st. The wires supplying current to the several lanterns are connected to an indicating and alarm box placed on the bridge or in any suitable position fully in view of the officer or officers in charge of the ship; and in each lantern two or more electric lamps are provided so that in the event of any one failing another one may be at once lit up. The several electric lamps are arranged in parallel or are supplied by separate wires so as to be completely independent of each other. In the indicating and alarm box there is a separate compartment for each of the three ship's lights; and in each compartment there is a small incandescence indicator lamp which becomes lit up, on any mast-head or side light failing, but is otherwise dark. The lighting of an indicator lamp and the ringing of an electric alarm bell which takes place at the same time are effected automatically. 2 claims.

21,651. "A new or improved method of making and breaking electric circuits, and apparatus therefor." W. H. DINGLE and J. M. URQUHART. Dated December 10th. The inventors employ two contact pieces as is usual, and they cause the movable contact piece to reciprocate or approach to and recede from the stationary contact piece in a right line. Of the two movements mentioned they cause the movement of the free piece to the fixed piece to take place by external manual pressure, and the movement of the free piece from the fixed piece to take place by the action of a counter spring, which is compressed or deflected by the first movement mentioned, namely, that of the free piece towards the fixed piece. In connection with the said free piece they employ a detent to lock it in position when it has been moved into contact with the fixed piece. The circuit is now made or closed, and remains so until the detent is released. To release the detent so as to break or open the circuit they employ what we may term a releasing device, which on being partially rotated or moved in an angular direction frees the detent so as to enable the counter spring to force the free piece away from the fixed piece and bring the parts again into their original position. 4 claims.

21,668. "Improvements in electric switches." A. MARR. Dated December 11th. According to these improvements, the switch is constructed with two pairs, or a pair and a set of contacts, of which it is arranged that the contacts of one pair or of one set only can complete the circuit at the same time, the other set or pair being open. 2 claims.

21,702. "Improvements in and relating to the construction of electrodes of large dimensions for accumulators, and to supporting the same in their cells." W. P. THOMPSON. (A communication by A. V. Kerckhove, of Brussels.) Dated December 11th. Claims:—1. The improvement in the construction of electrodes of large dimensions for accumulators, consisting in placing in the cases of a rigid grating or frame a given number of electrodes of any suitable size, and preserving to each of them its independent action, the whole producing an electrode of large dimensions and of great electric capacity. 2. In the construction of electrodes of large dimensions, fastening the electrodes in their cases by soldering them at one or more points on one of their sides to the corresponding cross bars of the frame, and supporting them at other points by means of little lugs projecting either from the electrodes or from the cross bars, substantially as described. 3. The employment for supporting in their cells large electrodes throughout their entire length, of strips or wedges arranged in parallel planes to those of the surfaces of such electrodes, substantially as described and shown.

22,184. "Improvements in or relating to telephones and microphones." A. RETTIG. Dated December 18th. Consists principally in combining in each instrument, whether microphonic or telephonic transmitter or receiver, several diaphragms of various sizes, and of the same material or of different materials, in such a way that the larger but weaker vibrations of the first diaphragm, the receiving diaphragm of the instrument, are converted into stronger vibrations of less amplitude upon the last diaphragm, by which the ultimate result of the particular instrument is effected. 4 claims.

CORRESPONDENCE.

Train Lighting.

Referring to the correspondence which has lately taken place, through the medium of your columns, between Mr. Evelyn Liardet and Mr. Houghton, perhaps, as I have been chiefly instrumental in developing the system of train lighting by electricity now in use on the Great Northern Railway, and therefore can speak with some authority on the subject, I may be permitted to offer a few remarks in support of Mr. Houghton's statements.

I have *myself* carefully examined all the patents to which Mr. Houghton refers, together with several others which have been taken out since the development of accumulators rendered train lighting by electricity practicable, and I must say that if vagueness may be taken as evidence of perfection in a patent specification, Mr. Evelyn Liardet has succeeded admirably. But it is doubtful whether any person of ordinary intelligence, without considerable previous experience, and *inventive capacity*, would ever succeed in lighting a railway train if he were to follow Mr. Evelyn Liardet's specification to the letter.

This being the case, it is hardly likely either Mr. Houghton or anyone else would wish to plume himself with Mr. Evelyn Liardet's feathers, and the sooner he disabuses his mind of the idea that he has the right to monopolise axle driving as applied to the lighting of railway carriages, the better.

F. W. Cooke, M.I.E.E.

Great Northern Railway, Retford,
June 14th, 1893.

Electro-Medical Treatment.

In these days of electrical progress, it appears to me that there is one branch of the science which has been much neglected, notwithstanding the prominence which has been given to it by the advertisements of one *eminent* firm—I allude to medical electricity. Now, Sir, I believe I have hit on a very valuable discovery, and one likely to be of inestimable benefit to suffering humanity, and I propose to make the public a present of it through your columns, for two reasons, partly from pure philanthropy, but partly and chiefly because I have not that balance at my bankers which would justify me in launching into that wholesale advertising which seems necessary in these days to make medical electricity a commercial success.

My invention, therefore, is briefly this. The object of the two or three best known modern systems appears to be to cause a mild current of electricity to pass over the skin. But I propose to increase the efficiency by including the whole mucous membrane in the field of operations, and thus to cause my cure to operate internally as well as externally, and my *modus operandi*, which is simplicity itself, is as follows: The patient requiring treatment first eats a charcoal biscuit, and then rubs his skin with zinc ointment; he afterwards makes a moderate meal of rhubarb or gooseberry fool, and the trick is done.

The acid acting on the charcoal will set up a current, which will pass gently over the coats of the stomach, throat, mouth, and skin with the most beneficial results, and effect a cure

without the use of belts, discs, or any similar cumbersome and uncomfortable Harness (beg pardon, small *h*, please).

Electricians may argue that, strictly speaking, the acid should come in direct contact with the zinc, and not with the charcoal; but in that case, it would be necessary to swallow the zinc ointment and rub the skin with a charcoal biscuit; but as, in that case, the remedy would possibly be worse than the disease, it will be as well to leave the treatment in the form I have prescribed, and even at that, I do not doubt it will be found as effective as any existing systems.

If preferred, rhubarb or gooseberry tart might be substituted for the fool; but as the latter confection would appeal to the homœopathic branch of the medical profession on the grounds of *similis similibus curantur*, it may be as well to leave the prescription as first suggested.

Trusting that, for the good of the general public, you can find space for this.

R. B. Pownall.

June 15th, 1893.

Heating by Electricity.

I notice an article appearing on page 711 of your issue of June 16th, on "Heating by Electricity," by Mr. Rankin Kennedy. I find his patent for heating by induction from alternating current is numbered 9,956—1890. It may interest Mr. Kennedy to know that I filed a specification in conjunction with Mr. Robert Hammond, on March 31st, 1890, the No. being 4,993, for precisely the same thing.

In order to show how closely my specification agrees with that of Mr. Kennedy, I will quote a short extract.

"In one form of apparatus, according to our invention, a coil of wire traversed by an alternating current surrounds a core of iron. This core is a hollow cylinder open at one end and closed at the other. It serves as a saucepan to contain liquid to be heated."

A number of diagrams were submitted with the specification showing different ways in which the arrangement may be applied, as for instance, boiling water, for cooking, for warming curling tongs or shaving water, foot and bed warmers hot water circulating appliances, and radiators for warming rooms, &c. After the specification was filed, I had a careful search made, with the result that I was advised by my agents that it had been anticipated.

As the two armature induction motor of Mr. Rankin Kennedy was protected by him only a short time before an application was made by me for a patent on precisely the same lines, and which, consequently, I was obliged to abandon, I think it only fair that Mr. Kennedy should know that he is out of the running this time.

Numerous appliances were made by myself, and experimented with at the works of the Brighton and Hove Electric Light Company, both on the question of heating and the motor mentioned.

Apologising for taking up so much of your valuable space.

Albert Gay.

A Curious Transformer Experiment.

Mr. Rankin Kennedy, on page 676 of your valuable paper, has expressed the wish that the phenomenon which he has observed might be explained. The explanation is exceedingly simple. A well-known theorem says that movable pieces of iron always arrange themselves in a magnetic field so that the number of the lines of force passing through them may be as large as possible. Hence it follows that when the U-shaped pieces of iron tend to withdraw from each other, the number of the lines of force passing through them is greater than when thrust closely together. The coefficient of the mutual induction increases with the number of the lines of force, and consequently the electromotive force in the secondary coil. That the number of the lines of force is, in fact, reduced by the approximation of the U-shaped pieces of iron, follows at once from the following consideration:—Two magnetising forces act upon the U-shaped pieces of iron, firstly, the magnetising power of the coil, and, secondly, the antagonistic or demagnetising power of the remaining pieces of iron. As these are fixed with their homonomous poles together, their magnetisings enfeeble each other the more the slighter their mutual distance. On the basis of this consideration, the phenomenon described by Mr. Rankin Kennedy loses all its noteworthy character. Analogous phenomena may be observed in a Hedgehog transformer, if the divergent iron wires which issue from its wrapping are made parallel.

F. Uppenborn.

Mr. Mordey's explanations of this effect is the one which I think is the correct one; when the plates are parted, the lines of force may be imagined as entering the plates by their sides or flat surfaces, and when pressed together the lines enter by their edges only. Iron filings on a sheet of paper laid over the coils with iron parted and the coils excited by a continuous current, show clearly the curving round of the force between the plates and on to the flat surfaces.

The effect occurs whatever plates are used, and with the plates of a closed magnet transformer. I have not tested the effect on the primary coil, so cannot give a positive opinion on Mr. Mordey's statement that the lamp would be brightest when placed in the primary with the plates closed together. I suppose he means the choking effect of the iron would be least when massed together; first opportunity I have I shall test this point.

Mr. Boult's concluding sentence seems to me altogether illogical; his explanation may be easy, but it is to me far from simple.

Rankin Kennedy.

Re The Incandescent Lamp in Waterworks.

In the ELECTRICAL REVIEW of 9th inst., I notice a short article under the above heading. Allow me to point out that the incandescent lamp has been known in waterworks for some time, as four years ago I carried out an installation for Messrs. J. G. Statter & Co., at the Hampton pumping station of the Southwark and Vauxhall Water Company.

Mr. J. W. Restter, M.I.C.E., who is the engineer-in-chief of the company, in writing to me a few months ago, stated that the installation had been a great success, and had saved them a very considerable sum of money.

The light was installed right throughout, and in the buildings connected with the station. The gas meter has been turned off ever since.

George B. Garvey, *A.M.I.E.E.*

Electrolytic Chlorine and Soda.

Much as I have occasion to feel indignant at the misleading statements of Mr. Emile Andreoli, published in your *Journal*, regarding my electrolytic work and patents connected therewith, some of which he must be ignorant of, because not published, I would ask, to close this unprofitable correspondence, that, having regard to the many misleading statements he has made (they are considered as such by men capable of forming an accurate opinion, and whose opinion Mr. Andreoli is bound to respect), and to my interests and feelings, as well as to the fact, though not perhaps so important, that Mr. Emile Andreoli, privileged though he may to some extent be as a journalist, has considerably overstepped the line of etiquette in this matter, that he should now be requested to cease repeating them.

According to Mr. Andreoli's own showing, there is room for hundreds of practical workers in electrolysis, and all I can add thereto is, that he and others have a fair and open field. If he thinks he can beat the results obtained at Snodland by the Electrolytic Chlorine and Soda Trust, why on earth does he not put up works and prove it on a similar practical scale, because no one can accept his mere theoretical estimates for practical comparison.

James C. Richardson.

Snodland, *June* 20th, 1893.

ELECTROLYTIC CHLORINE AND SODA.—We have received a further letter from Mr. Andreoli on this subject, which was evidently inspired by our footnote at the end of correspondence last week, but as we did not give publication to Mr. Richardson's letter, for the reason then stated, we must also decline to publish that of Mr. Andreoli.—EDS. ELEC. REV.